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The Institute of Vitreous Enamellers

The Welsh Engineers' and Founders' Association

and

The Foundry Trades' Equipment and Supplies Association

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Contents

	PAGE
Fifty Questions	171
Correspondence	172
The Polish Congress	172
Notes from France	172
Random Shots	172
Production of Cylinders for Private-Aircraft Engines	173
Foundry Cricketers Recapture the Lichfield Trophy	174
Budgetary Control and Standard Costs	175
American Notes	176
Surmounting Difficulties in Foundry Practice	177
Investigation of the Time of Ramming Sand	178
Catalogues Received	180, 184
Theoretical and Practical Significance of Graphitisation in Cast Iron	181
Underground Corrosion of Pipe	182
The Week's News in Brief	186
Trade Talk	186
Obituary	186
Company Meeting	186
New Master Cutler	186
Company Reports	186
Imports of Pig-Iron into the Argentine	186
Contracts Open	186
New Companies	186
Raw Material Markets	188

Fifty Questions

Though we have not always seen eye to eye with the National Safety First Association in the past, usually because we have not given full approbation to the poster activities, we must endorse wholeheartedly their latest publication. It bears the caption "The Factories Act, 1937," and is published at the modest price of fourpence from 52, Grosvenor Gardens, London, S.W.1. What has especially attracted us is the printing of fifty check questions on the Act. We do not believe it will detract from the value of the booklet if we reproduce the first eight questions. The bracketed number at the end of each question refers to the section of the Act. These eight questions read :—

(1) Have you made arrangements for the daily removal of dirt and refuse and the weekly cleaning of floors? (1)

(2) Do you know definitely whether your various shops comply with the requirement of 400 cub. ft. of air per person employed (as against 250 cub. ft. in the previous Act) except in places that were definable as workrooms up to July, 1937? (2)

(3) Will the existing arrangements maintain a temperature of at least 60 deg. in each room where the work is mainly sedentary and is there a thermometer in every such room? (3)

(4) Are all parts of your works, where people work or pass, efficiently lighted? (5)

(5) Are windows kept unobstructed and clean, inside and outside? (5)

(6) Have you observed that the fencing requirements for some prime movers are more stringent?

(7) Have you provided cut-out for the power in every room where work is done? (13)

(8) Have you so arranged matters that belts cannot rest or ride on revolving shafting when not in use, *e.g.*, by the provision of belt perches? (13)

We believe that anybody who has put an "O.K." against a few questions will experience the same reactions as a solver of a crossword puzzle, and will pursue the study to the end.

Though the proposed compulsory employment of a safety-first officer for large concerns has not been put on the Statute Book, it being considered that discretion should be left to the individual employer, yet we feel reasonably certain that if these fifty questions were honestly answered by a responsible executive, there would be no need for such an official. The question of engaging a welfare officer is entirely different, and his or her worth will depend on the locality of the factory and the type of employee. In the older urban localities, the employment of such an official is desirable, but tends to become less necessary in settled rural districts. Again, if the direction of a large concern is overworked with commercial and technical matters, then the notion of combining the activities of a safety-first and welfare officer into one responsible individual has much to commend it. Initially, however, the Board must decide whether such a person is to be empowered with executive authority or whether he is to remain purely in an advisory position. The latter is preferable, as it leaves the various managers and foremen in a position where they must co-operate. We do not believe that a safety-first officer can know the risks to be associated with the running of each department. Such questions as the stacking of pig-iron, the maintenance of clear roadways, the proper upkeep of chains and hoists are fairly common knowledge, but no safety-first expert could be expected to know much about the weighting of moulds and their freedom from dampness. Generally speaking, we do not like people about works who, though vested with no real authority, act in an advisory capacity, for usually much bickering is engendered. However, as any "mentally disturbed" atmosphere is productive of accidents, a properly-trained safety-first officer should be well capable of preventing such conditions. If a spirit of co-operation cannot be ensured, then a new safety officer and not a new foreman is required. It is interesting to study just at what strength of the labour force the employment of a safety officer becomes desirable. The obvious basis would be the number of persons employed, yet an examination of the available statistics would show that accident incidence is increased with the increasing employment of juvenile labour. The ratio of skilled to unskilled men is another governing factor.

Finally, as a general and sincere contribution to the reduction of accidents within the foundry industry, we ask the executives to buy this fourpenny pamphlet and to answer honestly the questions posed.

Correspondence

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Sand at Elevated Temperatures

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—With regard to Mr. F. Hudson's foreword to the article by Mr. R. F. Hudson on "Sand at Elevated Temperatures," printed in your issue of August 4, I think the remarks regarding the neutralisation of expansion of sand by clay up to as much as 20 per cent. probably originated from myself. In order to avoid a misunderstanding on this, I would point out that the remarks were a theory and not a fact, and the theory was the subject of sand experiments which were about to be conducted.

The experiments, which were made with baked wet loam, are now partially completed, and the results show that the useful range of clay content is fairly limited. At least 10 per cent. of clay is essential in a core to make reasonably certain of freedom from metal erosion, and 15 per cent. of clay is the maximum which can be present if buckling can be avoided. On a series of cores containing from 8 to 20 per cent. of clay the maximum expansion on 2 in. was measured. For the 8 per cent. material the figure obtained was 0.029 in., and this was progressively less until 0.022 in. was obtained for the 20 per cent. mixture. Higher percentages of clay were tried, but fusion of the clay in the loam took place at relatively low temperatures, with consequent erratic results.

It would appear that below 15 per cent. of clay the silica particles have sufficient freedom of movement to allow them to pack themselves more tightly, and thus afford some counteraction to the expansion as a whole. Over 15 per cent. of the clay appears to give the mass so much rigidity that the silica particles cannot pack any tighter, with the result that the core attempts to expand as one piece and the resistance of the mould is sufficient to cause partial restriction of the movement, with consequent buckling.

Another point which enters into the question is the comparatively low softening temperature of many of the clays in moulding sands, and in work dealing with sand at elevated temperatures this softening is very apt to interfere with the expansion figures obtained from laboratory tests. The foregoing figures have, however, been corroborated by foundry tests on pipe and venturi tube cores.—Yours, etc.,

J. E. O. LITTLE
(Chief Metallurgist).

Glenfield & Kennedy, Limited,
Kilmarnock.

August 27, 1938.

The Polish Congress

Some last-minute cancellations have reduced the strength of the British delegation to the International Foundry Congress which is being held in Poland from September 8 to 24. These, due no doubt to the obscurity of the political situation, included Mr. V. C. Faulkner, Dr. A. B. Everest and Mr. C. J. Burgess.

Leaving Liverpool Street station last Tuesday morning were Mr. T. Makemson, Mr. V. Delport, Mr. Spring (Metters, Limited, of Australia) and Mr. E. Millington (Derby). At Berlin they will be joined by Mr. and Mrs. John Cameron and Mr. and Mrs. John Cameron, Junior. Mr. and Mrs. F. W. Hobbs (Benoni) and Mr. John Shaw (Southsea). In Warsaw, the party will be augmented by Mr. Pike, of High-Duty Alloys, Limited, who is flying over.

Notes from France

(FROM OUR SPECIAL CORRESPONDENT.)

The situation on the French pig-iron market continues to go from bad to worse. Reports for the month of July, just issued, indicate that nine further blast furnaces closed down, with seven additional ones preparing to do so. By the end of July only 75 furnaces remained in operation. The fact that no relief of the situation appears to be in sight is causing continued pessimism. Even the suggestion that the Government may allow the industry to work more than 40 hrs. per week is received with no feeling of relief.

The difficulty for the works lies in the fact that the consuming industries are under-producing, and the relaxation of the 40-hr. week law will not affect them except in the national defence industries, whose consumption is considered insufficient to cover the production capacity of the furnaces. Another difficulty is the failure of the price pegging commissions to grant a demand for increased pig-iron prices. Ironmasters insist that the motives of this refusal are political and that the increase is fully justifiable. Even though the autumn is generally the season for improved consumption, the French industry feels little hope. The stocks of pig still on hand are sufficient to permit most plants to go several months without further orders.

Organisation of Foundry Industry

The serious situation in the foundry industry in France has brought with it a renewed interest in the Foundry Employers' Federation, and has led most of the foundries in France, numbering nearly a thousand, to join the organisation. This has been developed on rather interesting lines, on a combined horizontal and vertical system. Foundries are grouped regionally in regional syndicates, which unite to form a national one. In each regional syndicate, however, special subdivisions group all the founders specialising in a certain branch of work (bath tubs, radiators, plumbing supplies, etc.), and these specialists also maintain contact with the foundries in the same line of business in other regions, through the national organisation.

This rather complicated system has the advantage of permitting the most effective exchange of technical information and ideas of organisation. To facilitate this, the Presidents of the regional syndicates are chosen in the usual manner, but the organisations of specialists are headed not by ordinary Presidents, but by engineers, who may be chosen outside the industry if their qualifications justify it. In this way commercial and industrial questions are studied by founders, while technical questions, which vary from one branch to another, are handled entirely by technicians.

The aim of the system, Mr. Maurice Olivier, the national President, points out, is to bring about an evolution in the foundry industry in France so that founders specialising in one particular branch can work in technical and even commercial collaboration with those in the same branch in other regions Eventually, Mr. Olivier hopes that it will even become possible to centralise all foundries working in a given line, so that they will be grouped in one region, in as far as such a system proves economically desirable. Meanwhile, the syndicate, through its technical services, has been able to obtain not only the collaboration of the research laboratories of the various founders, but to set up a syndical laboratory for its technicians.

No. 2 FURNACE has been put into blast again at the Derbyshire works of the Staveley Coal & Iron Company, Limited, after being idle since the early part of June.

Random Shots

Many visitors to the German foundry conference two years ago will remember the foundry at Cologne with its flourishing flower beds and gay window boxes. Famous, too, is Barr & Stroud's foundry in Scotland, where birds are encouraged to nest among the crane staunchions. Now "Marksman" is told of a touching instance of nature's adaptability at the foundry of S. Russell & Sons, Leicester. There had long been a piece of waste ground by the river on which swans had built their nest year by year. When the firm built a new foundry on this site, only a narrow strip of ground was left between wall and water's edge. This year the swans, deprived of their accustomed spot, have built their nest on this ledge, and the moulders spend a good part of their dinner-hour feeding and watching the young cygnets. Perhaps next year they will be offered a more comfortable nesting ground among the sand bins!

* * *

Put that in your tube and pipe it! A staff member of Stewarts and Lloyds has had the distinction of being the eight millionth visitor to the Empire Exhibition. He and his family were (figuratively) piped round the exhibition the whole evening, being entertained free of all cost! The lucky man was a Scot, and so naturally thoroughly appreciated such generosity for what it was worth, which must have been a great deal by the time the evening was over!

* * *

A man from Sheffield had just been appointed London manager for his firm, and he and his wife moved into a beautiful new flat. It was in one of those great blocks which look like advertisements for steel tubes when they are being built, and when completed might be mistaken for the new Gillette factory. Inside it was so thoroughly all-electric that even the rent gave one a shock. Their friends came all the way from Sheffield to see them, but once the flat was self-contained it just couldn't contain anyone else. It was so small, in fact, that the keys in the doors had to be cut flat and thin. "They must ask a lot for the rent of this flat," said one of the visitors. (It is remarkable how blunt they are from that city of sharp knives and edged tools!) "I'm afraid they do," confessed their host. "Last month they asked at least half a dozen times."

* * *

The same London manager soon found his expenditure rather inconveniently greater than income, so he wrote to his directors asking if they could raise his salary next quarter. The reply came (proving thereby that blunt men are sharper than one would think): "Your directors, whilst appreciating your concern, wish to say that they have so far managed to raise your salary and confidently expect to be able to do so again when it next falls due!"

* * *

Congratulations to the Institute's cricket eleven. A convincing five-wicket victory has been won in the annual match against the Works Managers' Association. The outstanding features were that Hutton made a duck, whilst that other august Yorkshireman, Webster, carried off the batting honours, as well as being well up in the bowling averages. Chubb was particularly "safe" in the slips; Roxburgh apparently, as an old international footballer, thought he was feeding his wings when he pushed the ball into the hands of Jack Gardom. It is rumoured that both Shotton and Gardom are now on the W.M.A. transfer list, and next year may be wearing the foundrymen's colours! Both at least have a "residential" qualification.

"MARKSMAN."

Production of Cylinders for Private-Aircraft Engines*

By RAYMOND CHAVY

Some years ago the management of la Société des Moteurs Potez began to look into the possibilities of making an engine for private aircraft which would be of low price but of a power rating per unit weight greater than those of similar existing engines. This engine was air-cooled, with cast-iron cylinders and light-alloy casings. In respect to the cylinders, which up to then were of ordinary pearlitic iron, the weight reduction which was necessary required the following properties from the cast iron:—

(1) *Very high mechanical strength*, in order to be able to reduce the thickness in the bore to less than 3 mm.

(2) *High modulus of elasticity* to avoid, in spite of these relatively small dimensions, any deformation resulting from the tightening up of the rods used to hold the cylinder to the gear case.

(3) *Excellent wear resistance.*—In spite of the relatively-light normal working conditions of these aero-engines (1,500 to 2,000 r.p.m.) the metal ought to be wear-resistant because of the very high compression range (6.0 to 6.3), and especially because of the short length of the piston skirt, which sets up considerable lateral reactions. The metal ought not to seize in contact with "Y alloy" pistons and should therefore contain an adequate graphite content.

(4) *High flowing power*, permitting the fins to be made about 1.5 mm. thick, their depth being 18 mm.

These desiderata are in part contradictory, because to improve strength and the modulus of elasticity, one has to have recourse to low-carbon irons, whereas to increase flowing power and improve the wear-resistance it is preferable, on the contrary, to increase the carbon.

After several tests the following chemical composition has been adopted:—C, 2.8; Si, 2.0; Mn, 1.2; P, 0.6 and Ni, 4.2 per cent. It is of interest that, in spite of the relatively high phosphorus content, the mechanical properties are excellent. For a Brinell hardness, after treatment, of the order of 280 to 320, the breaking load on the Frémont test-piece is of the order of 680 to 800, which exceeds the requirements of the specifying bodies for high-strength cast irons.

The first tests were carried out on low-nickel cast irons, which, it was thought, could be treated after machining in order to obtain a martensitic quench by simple air-cooling. The nickel content was at about 2.8 per cent. Experience has shown that an air quench from 850 deg. C. brought about in the tips of the fins, which always contain a small quantity of cementite, shrinkage cracks which were hardly visible but which could not be tolerated in aero-engine cylinders.

After these tests, by increasing the nickel, it was sought to obtain a martensitic quench by simple cooling in the mould, which called for 4.0 to 4.2 per cent. nickel and 1.2 per cent. manganese. The most suitable iron is martensitic in the as-cast state on account of the castings being thin and rapidly cooled; its hardness is then 380 to 420 Brinell, and the metal is practically unmachinable.

To facilitate machining it is necessary to carry out an anneal similar to that which is nowadays practised with special steels. This annealing is done at a temperature of the order of 600 deg. C., which is held for about 2 hrs. to obtain sufficient softening and, above all, to eliminate as completely as possible the internal casting strains which are liable to cause deformation from heat generated under service conditions.

This anneal demands special precautions, if one wishes to avoid shrinkage cracks in the tips of the fins of the same kind as those produced by air-quenching. The heating from room temperature ought to be gradual, and should be followed by slow cooling in the furnace down to normal temperature. The complete cycle requires about 24 hrs.

It has been mentioned that the cracks in the fins are produced sometimes during the cooling of the castings in the mould. To avoid these cracks the castings, while still hot and covered with sand, are placed in a pit furnace where cooling takes place slowly throughout a night.

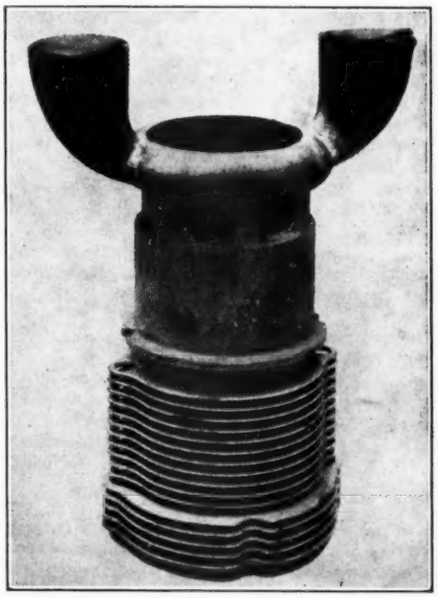

FIG. 1.—METHOD ADOPTED FOR RUNNING CYLINDERS FOR AERO ENGINES.

At the present time the castings are knocked out hot and taken with the surrounding sand direct to an annealing furnace which has been previously heated up, in such a way that the annealing is carried out much more rapidly. The castings are held for 2 or 3 hrs. at 600 to 620 deg. C. and cooled slowly in the sealed furnace.

Melting is done in an oil-fired crucible furnace with a capacity of some 4 cwts. of iron. The charge is made up of:—English hematite (C 3.7, Si 0.9 per cent.), 60-70 kg.; phosphoric iron, PL3 (C 3.0, P 1.5, Si 3.0 per cent.), 40 kg.; spring steel (C 0.4-0.6, Si 1.0-1.5 per cent.), 10 kg.; scrap from previous melts, remainder.

Melting is carried out under a glass slag as quickly as possible, the nickel and ferro-manganese being added in the molten bath.

When the metal is sufficiently hot a chill test is taken. The depth of chill should be of the order of 6 to 8 mm.

A quarter of an hour after pouring, the castings are taken to the annealing furnace and submitted to the treatment outlined above.

Moulding is done on a stripping machine with withdrawal of the fins through a stripping plate; the pattern being reversible, one machine and one stripping plate suffice for production.

The facing sand is a mixture of high-silica sand (82 per cent. approx.), argillaceous sand (15 per cent. approx.) bonded with Avèbène (1.5 per cent.) and linseed oil (2.5 per cent.) to increase the green bond strength.

To avoid sand-grain inclusions from the runner, on the "business" surfaces of the moulds is sprayed an emulsion of water, linseed oil and silicate of soda, which, without markedly diminishing the permeability, further increases surface cohesion after drying.

Pouring is effected by the type of runner shown in Fig. 1, by the relatively thin (2-3 mm. thick) slots leading from a circular pouring basin of generous proportions. Assembling is done after stoving whilst the moulds are still hot, which diminishes the tendency for chill in the fins. Pouring as hot as possible is practised in order to avoid "short runs" in the fins.

It is of interest to recount an incident which happened during the early stages of production. The metal was then tapped from the crucible into refractory-lined ladles and poured direct into the moulds. At the end of a certain period frequent inclusions were found of fine slag particles, as large as pinheads, but enough often to lead to the rejection of cylinders, these being subject to rigorous inspection. After having made numerous tests by changing the method of pouring, improving the sand cohesion, decreasing the thickness of the slot ingates, all these tests being made without success, it was seen that these slag particles resulted from the attack on the ladle refractory by the very hot metal. The iron used being relatively low in manganese, it probably is produced, by surface oxidation of the metal at high temperature, from manganese oxide which attacks the acid lining. Therefore, the refractory-lined pouring ladles were replaced by graphite crucibles and the trouble disappeared. The foundry wasters which had become very high were reduced immediately, by this one step, to 3 or 4 per cent.

From a technical point of view it is interesting to note that the saving in the cost price made possible by the use of special cast-iron cylinders in place of steel cylinders has been very notable, corresponding to a reduction of the order of 7 to 8 per cent. of the total cost price of the engine (6-cylinder star engine). This saving in price, it will be understood, is obtained by accepting a slight weight increase, but on the engine in question this is no more than about 5 per cent. (increase of weight of 6 kg. on a 130-kg. engine).

This example shows that by the logical use of special cast irons one can produce castings of excellent mechanical properties, and really sound, which are able to compete, by virtue of their low price, with castings of even special steels. As a final remark it may be added that the wear of cylinders in service is distinctly less than that of castings in special or treated steels. On one of the first engines fitted with these special-iron cylinders, the wear, after a run of some 1,000 hrs.—corresponding to more than 100,000 km.—was less than 3 hundredths on the diameter for all the cylinders of a six-cylinder engine, the general mean being of the order of 2 hundredths of a millimetre.

* Abstract of a lecture given to the Old Students' Association of the Foundry High School, Paris, translated from "La Fonte."

Brightside Foundry & Engineering Company, Limited

The annual meeting of the Brightside Foundry & Engineering Company, Limited, was held in Sheffield last week. MR. FRED W. FIRTH (chairman), who presided, said that the year's working had easily broken previous records, and their turnover was more than five times the amount of their subscribed capital. Conditions in this country during the last 12 months had been good, and their foundries had been well occupied throughout the year producing castings weighing up to 150 tons each, while their roll trade had further expanded, particularly in alloy rolls. They were, however, meeting with severe competition, especially in their engineering department, which was largely interested in the manufacture of rolling mills and plant for steelworks and the non-ferrous industry.

Foundry Cricketers Recapture the Lichfield Trophy

FIVE-WICKET VICTORY OVER WORKS MANAGERS

Few moments in the Saturday afternoon of the last Leeds Test Match could have been so exciting as was the last hour of the match played at Withington Barracks, Lichfield, last Sunday between the Institute of British Foundrymen and the Birmingham Branch of the Works Managers' Association. Of course, in the former case the home of the Ashes was at stake, but even so unique a trophy as that can hardly be compared with the "beautiful ugliness" of the gargoyle which forms the Lichfield Trophy.

After luncheon at the George Hotel, Lichfield, the fifty-odd people who had gathered to witness, and participate in, this battle royal made their way to the Barracks ground there to discover Jack Gardom, captain of the W.M.A. team, already on his hands and knees making a close inspection of the wicket. Lennox Holt, who eventually led the I.B.F. side to victory, was not so concerned, and was apparently prepared to accept the reports and advice of his various "scouts" as to the state of the turf.

The First Wicket Falls

The customary toss of a coin decided whose lot it would be to set the ball rolling, so to speak, and as a result, Lennox Holt led his men on to the field at 2.45 p.m. The care with which the opening batsmen dug themselves in against the bowling of F. Webster and F. W. F. Russell gave many onlookers the impression that they had come to witness yet one more timeless test match, but in the eighth over F. Webster clean bowled J. Mason, with a total of fifteen on the board. This was a great piece of work, for rumour has it that this batsman has already undergone some fairly successful trials for Warwickshire.

From a foundryman's point of view, the game took a decided turn for the better, for although the batting did brighten up considerably and there was a stand of some fourteen runs before the next wicket fell, R. W. Sparks was brilliantly run out when the total was 39. The next two wickets fell comparatively cheaply after Holt had made two quick bowling changes and had brought on W. F. Chubb and G. T. Hampton, but after this, J. Drummond gave a lively display of batting, and the other batsmen managed to hold their end up. True it is that Drummond gave one or two chances, but these only added to the enjoyment of his otherwise masterly batting.

Dick Shotton having deserted the I.B.F. in favour of the other side, many foundrymen were particularly pleased with Tipper when he dismissed Shotton "leg before." How much assistance the bowler received from Umpire Tipper is not certain, but that Dr. G. H. Froggat, the other umpire, had a friendly grudge against Jack Gardom is now known, because at dinner in the evening Dr. Froggat made the confession that he had intended to give the W.M.A. captain out at the first appeal made against him! Thus it was that after withstanding about three balls from the I.B.F. star bowler, G. T. Hampton, Gardom, in a bold attempt to play a defensive stroke, was given out l.b.w. It would be unfair here to enlarge upon the value of his score; reference to the score-sheet at the end will convince readers of the accuracy and deadliness of the I.B.F. bowling which Lennox Holt managed so well.

With a total of 113 on the board, and J. Drummond still undefeated, the Works Managers were all out at five o'clock, and the players adjourned for tea.

Within a quarter of an hour the W.M.A. side took the field and were quickly followed by the I.B.F. opening pair—R. Axtan and F. Webster. Realising that his side would have to score at the rate of a little over a run per minute, Holt must have instructed the batsmen to take every possible chance of scoring, for within a very short time, Axtan's really first-class stroke play and F. Webster's powerful hitting had put confidence into the hearts of foundrymen. The record first wicket stand of 69, in the face of such bowlers as Gardom, Hutton, Saddler and Drummond is a feat to which future generations of foundrymen are bound to refer with pride!

Scoring against Time

When eventually Axtan's wicket fell to the wiles of Gardom's bowling, J. Roxburgh joined Webster for a short spell. He never seemed quite confident, however, and soon pushed a ball from Garside round into the safe hands of Gardom fielding close in on the leg side. Neither did W. F. Chubb stay long, and these two comparatively quick wickets necessarily caused slight delays which, as stumps were to be drawn at seven o'clock, gave Lennox Holt some anxious moments.

G. T. Hampton, however, held the fort well and allowed Webster to complete his fighting fifty, which was greeted with a loud blare of motor horns. At twenty minutes to seven Webster's wicket fell, and the excitement, which each moment was growing in the pavilion, was here and there replaced by the fear that a decision would not be reached in time.

W. L. Beasley realised the necessity of quick scoring and gave the onlookers a pretty display of "how to steal singles," and was only checked by the dismissal of Hampton. Apparently in fear that he would have but few other chances, A. G. Robiette ran all the way to the wicket, and after Beasley had scored a snappy single which equalised the score, Robiette, with a lovely drive through the covers, gave the I.B.F. the score with five minutes and five wickets to spare.

Of the fielding little has been said, but in truth some remarkably fine work was done by both the teams. Jimmy Bell proved that he could run from the wicket to the boundary in less time than it has taken to read this statement, whilst Holt at mid-on showed that as far as his hands are concerned he is a man of iron. Undoubtedly, however, the laurels must go to Axtan as the I.B.F. wicket keeper, for although seven byes are shown in the score sheet, only three balls beat him in the whole of the innings.

Trophy Presentation

The conclusion of activities at the cricket ground was the presentation of the Trophy to Lennox Holt by Alderman F. Garratt, of Lichfield, who afterwards awarded a lollipop to each player on the W.M.A. side. Mr. H. L. Satchell, President of the Works Managers' Association, then expressed the thanks of the spectators for the excellent game which they had witnessed, and the thanks of all present to Mr. J. E. Hurst for the arrangements he had made in connection with the match.

This little ceremony was not the end of the day, for about sixty people later sat down to dinner at the George Hotel. Soup had hardly been served before Mr. Gardom was unanimously appointed toastmaster for the evening, and before the next course he had commenced his duties. The loyal toast having been honoured, the health of the playing members of the I.B.F. was drunk, and this was followed by a toast to the ladies. The toast list appeared to be particularly long, and in order to save time at the end of dinner (apparently) all the toasts—which included those to "The British Army," coupled with the name of Major Gill (representing the O.C. troops at Withington Barracks); "The Umpires"; a second toast to "The Ladies"; "Mr. J. E. Hurst," organiser of the match; and "The City and Trade of Lichfield"—were proposed and honoured during the meal. Major Gill replied to "The British Army," Dr. Froggat to "The Umpires," and Councillor Bather, of Lichfield, to the last toast.

The evening ended with the singing of many songs (including the foundrymen's national anthem), which were amply illustrated by arm and other actions. Dr. Froggat, Mr. Hurst, Mr. Lennox Holt and Mr. Gardom proved that they are all excellent choristers.

Below are given the score sheets of the match:

WORKS MANAGERS' ASSOCIATION.

J. Mason, b. Webster	8
J. L. Norris, c. Axtan, b. Hampton	17
R. W. Sparks, run out	5
R. Garside, b. Chubb	1
J. Drummond. Not out	55
R. Darby, c. G. Lunt, b. Webster	3
A. Saddler, c. Chubb, b. Russell	7
G. R. Shotton, l.b.w., b. Roxburgh	1
J. W. Gardom, l.b.w., b. Hampton	6
P. Hutton, b. Hampton	0
D. Richards, b. Chubb	6
Byes	7
Leg Byes	1
	113

Bowling.

	Runs.	Wkts.	Overs.	Maidens.	Average.
F. W. F. Russell	19	1	6	0	19.0
F. Webster	14	2	10	5	7.0
G. T. Hampton	20	3	9	0	6.6
J. Roxburgh	18	1	6	0	18.0
W. F. Chubb	23	2	7.4	0	11.5

INSTITUTE OF BRITISH FOUNDRYMEN.

R. Axtan, c. Hutton, b. Gardom	29
F. Webster, b. Garside	51
J. Roxburgh, c. Gardom, b. Garside	3
W. F. Chubb, b. Drummond	3
G. T. Hampton, c. Saddler, b. Drummond	8
W. L. Beasley. Not out	11
A. G. Robiette. Not out	8
F. W. F. Russell, G. Lunt, J. Bell, and L. Holt did not bat.	
Byes	9
Total for 5 wickets	122

Bowling.

	Runs.	Wkts.	Overs.	Maidens.	Average.
J. W. Gardom	26	1	7	1	26.0
P. Hutton	8	0	3	1	—
A. Saddler	15	0	5	0	—
J. Drummond	33	2	12	0	16.5
J. L. Norris	15	0	2	0	—
R. Garside	13	2	4	0	6.5

World Aluminium Statistics

Final figures for world production and consumption of aluminium in 1937, according to a review issued by the Aluminium Information Bureau, show that aluminium consumption has been in excess of production in each of the past two years, but, while world consumption has increased by 25½ per cent., production has increased by about 34 per cent. World production in 1937 was 482,900 tons, and world consumption was 493,800 tons. The United States of America and Germany are by far the largest producers and consumers of aluminium, together accounting for 54 per cent. of world production in 1937. Production in each of these countries increased by rather more than 30 per cent. in 1937 as compared with 1936, the U.S.A. producing 132,800 metric tons and Greater Germany 131,600 metric tons. The quantities consumed in 1937 were 154,000 metric tons in the U.S.A. and 132,900 metric tons in Greater Germany, showing increases of 21.3 per cent. and 26.9 per cent. respectively over the 1936 figures. In the United Kingdom production increased by 18.3 per cent. to 19,100 tons, against 16,200 tons in 1936, while consumption increased by 40 per cent. to a new record level of 48,200 tons. Consumption in Russia increased by 23.7 per cent. to 47,000 metric tons, and in Italy by nearly 53 per cent. to 26,000 metric tons.

Budgetary Control and Standard Costs

II.—REPETITION FOUNDRIES AND THE BUDGET

By T. McALPINE

(*Continued from page* 156.)

Payroll Budget

The requirements of the management will decide the information to be shown by the payroll budget. In some instances it may be designed to show the wages payable under the headings of skilled, semi-skilled, and unskilled labour. It may show wages only, or it may show number of employees as well as wages.

Form 8 shows one application of a payroll budget. The number of employees is ascertained by dividing the wages payable for each grade by the average yearly wage for that grade. Of course, each grade must be shown separately, or otherwise a true figure for number of employees would not be ascertained. The budget would be sub-divided to give weekly, or fortnightly, figures.

Allowances for replacing defective castings, idle time of employees, etc., are best omitted from production budgets, but must be allowed for in the payroll budget, as this will affect the wages figure and the number of persons to be employed. The other section of the payroll budget will give the salaries to be paid in each department. Where the name of the department reveals the nature of the work for which the salaries are payable—*e.g.*, sales department, accounts department, etc.—no further subdivision is necessary. This is not so, however, with the production departments, and a subdivision is necessary to show the salaries payable in respect of supervision, clerical work, progress chasing etc. This information is utilised in preparing the oncost expense budget.

Oncost Budget

Oncost expenses originate from three sources:—

(*a*) Labour which is a service to production in one way or another but which cannot be charged direct to any particular product. These indirect labour charges are ascertained from time-sheets or job cards.

(*b*) Material which cannot be charged direct to any particular job or product. Details of material charges are obtained from material requisition slips.

(*c*) Sundry charges, other than above, which cannot be charged to particular jobs or products, for example, rates and taxes, power (if not generated on the premises), insurance, depreciation of buildings and machinery, etc. These charges can be obtained from the general books of account.

Therefore, in considering an Oncost Budget, ways and means must be found of estimating probable expenditure under each of these headings.

Indirect Labour.—Indirect labour must be estimated for each department separately, and this may be done on broad lines or prepared in detail from previous records. If a detailed estimate is not possible it is usual to determine indirect labour by proportioning it on the number of direct workers in each department.

If a more accurate method be required, then all services which come under the category of indirect labour must be analysed for each department and the number of workers required to perform these services determined. For example, the services to be done in the floor moulding shop may comprise all or any of the following jobs: wheeling sand, filling sand-mixing machines, transporting boxes, castings, scrap, etc., pouring metal, knocking out boxes, cleaning shop, etc. If the workers' time-sheets for the previous year show the time spent doing each of these jobs, it should be possible to determine the number of hours to be allowed for each of these services in the ensuing year, and if the number of hours under each heading is divided by the average number of hours to be worked by each employee during the year, then the number of workers necessary to perform each service will be known. In some instances these jobs may even be paid on a piecework basis, or again, a representative month can be taken as a basis instead of a year. To get this information involves a quantity of clerical work but it will justify the expense, where the foundry is a large one.

Indirect Materials.—The indirect materials to be used in each department can, like labour, be estimated on broad lines or in detail. A general estimate would base the figure on the material costs of each department for the previous year without regard to the quantities of each class of material used. The other method is to review cost accounts and stock records for previous periods and to list every kind of indirect material used in the foundry and show against each department the quantity, price and value of each class of material to be used for the ensuing year.

Incidentally, all direct materials excluding metal, alloys and melting materials (which are controlled by the cupola production budget) would be treated similarly, except that separate sheets would be used. For example, all coreshop materials used in making cores and which can be charged direct against particular jobs would be analysed in this way.

Sundry Charges.—Sundry charges can be estimated fairly accurately from previous records. They must be pro-rated over each productive department to arrive at a total oncost charge for each department, and reference to previous records should make this simple.

It is quite a common practice in foundries to allocate total oncost against direct labour at a fixed percentage for the foundry as a whole. That is, oncost is not departmentalised. This method of recovering oncost may be satisfactory in a few isolated cases, but it cannot be regarded as sound practice for the majority of foundries. It will ensure that the total oncost of the foundry is charged to the various jobs, but it usually implies that one job is overcharged at the expense of another. The reason, of course, is that the ratio of oncost to direct labour will vary in each department.

Form 9 illustrates an Oncost Budget as applied to a continuous casting plant. For oncost purposes a continuous casting plant may be regarded as comprising three units: (*a*) the sand supply and reconditioning unit, (*b*) the conveyor unit, and (*c*) the production unit as represented by the various moulding machines, which are sub-divided into groups of similar machines.

The object is to estimate the probable oncost expense for (*a*), (*b*) and (*c*) separately, and then to allocate the expense of (*a*) and (*b*) to each group of machines, according to the extent of the service which each group is likely to obtain. A satisfactory basis of allocating (*a*) and (*b*) would be the number of boxes or moulds which are likely to be produced by each group of machines during the ensuing year. If there is a wide variation in the size of the boxes used by each group of machines, then the capacity of the boxes may have to be considered in this allocation.

Form 9 shows the cost of operating each service and ensures that all expenses are finally included in the oncost of the various machines, and this oncost will be charged to the various products by means of a Group Machine Hour Rate. The amount shown against each expense item can be ascertained as follows:—

Rates, taxes, insurance, depreciation of buildings, heat and light can usually be allocated to each department, according to the proportion of total floor space occupied by each department. In some cases, however, light may be based on the number of lamps in each department.

Repairs to plant and buildings can usually be allocated direct to each department from time-sheets and material requisition slips.

Health and unemployment insurance, employers' liability insurance, welfare department expenses, administration, production planning and progress can be allocated in proportion to the number of employees in each department.

Depreciation of plant and machinery will be charged to each department direct, according to the value of the plant and machinery in the department.

Supervision and shop clerical expense will be a direct charge to each department.

The charge to each department for power can be based on figures supplied by the engineering department. The amount of the charge will depend upon the number of machines in each department, the power consumption of each machine per hour, and the number of operating hours of each machine during the period.

Sand, coal dust, etc., can be charged from requisition slips, or, as is more probable, a charge

PAYROLL BUDGET FOR YEAR ENDING 19 .

Description.	Cupola dept.	Pattern-shops.	Coreshop.	Loose-pattern moulding.	Continuous casting plant.	Cleaning dept.	Maintenance and repairs dept.	Total.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Production budgets ..								
Allowance for defective castings								
Allowance for idle time ..								
Plant and equipment budget								
(*a*) Additions								
(*b*) Repairs and maintenance								
Indirect labour (oncost budget								
Total								
No. of employees :—								
(*a*) Skilled								
(*b*) Semi-skilled								
(*c*) Unskilled								
Total								

Form 8.—Payroll Budget.

can be based on an estimated consumption figure for each department. Sundry materials can be charged departmentally from material slips.

General labour will cover such jobs as transporting sand, filling hoppers, cleaning sand conveyor belts, etc., and the charges can be made direct from time sheets.

Miscellaneous expenses include all items of expense which do not justify a separate account.

The three sections of a continuous casting plant, namely, the sand system, conveyor system, and moulding machines, are considered as three separate departments, and their respective shares of apportionable expense are determined on the basis stated above.

Purchases Budget

This budget serves many purposes. It shows the buying department the quantities to be purchased of each class of material and the approximate dates when these purchases should be made.

ONCOST EXPENSE BUDGET FOR YEAR ENDING 19 .

X No.	Description.	Sand service.		Conveyor service.		Group 1.		Group 2.	
		Material.	Labour.	Material.	Labour.	Material.	Labour.	Material.	Labour.
		£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
	VARIABLE EXPENSES.								
	Repairs and maintenance								
	Power								
	Light and heat								
	Gas								
	Water								
	Compressed air								
	Sand, etc.								
	Consumable stores								
	Health and Unemployment Insurance								
	Welfare								
	Supervision								
	Works, clerical								
	Planning and progress								
	Administration								
	Idle time								
	General labour								
	Miscellaneous								
	FIXED EXPENSES.								
	Depreciation: Buildings								
	" Plant and Machinery								
	Rates and taxes								
	Insurance								
	Share of sand and conveyor service								

Form 9.—Oncost Expense Budget as applied to a Continuous Casting Plant.

It informs the management of their financial commitments in respect of purchases. If the actual prices paid for materials show an increase on budget prices, inquiries can be made to confirm that the buying department is placing orders to the best advantage.

The fact that material prices are fixed for budget and costing purposes simplifies the control of material consumption, since any variation between budget and actual material costs must be due to a variation in the quantities used.

Auxiliary Departments Budget

This budget usually includes the probable cost of operating all departments connected with administration, and selling and distribution. It includes such departments as secretarial department, accounts departments, costing department, general offices, sales and despatch departments, etc.

The ultimate aim of this budget is to show the probable cost of operating the two services of: (*a*) administration and (*b*) selling and distribution. Administration is a service to production and to the selling and distributing departments, and its cost must be allocated to these two sections according to the benefits which each is expected to receive from this service.

The factory's share of this expense will be allocated to the productive departments according to the number of employees in each department. The share allotted to selling and distribution will be included in the total expenses of these departments.

Selling and distribution costs can, as a general rule, only be allocated to the products sold upon a very arbitrary basis. The usual method is to allocate selling and distribution costs as a fixed percentage on the production cost of the goods sold. The formula is as follows:—

Estimated selling and distribution costs for the year multiplied by 100 *divided by the production cost of anticipated sales for the year equals the percentage to be added to production cost.*

It will be noticed that three estimates are necessary:—(*a*) An estimate of sales; (*b*) estimate of the production cost of these sales, and (*c*) estimate of selling and distribution costs. The Sales Budget will provide a basis for (*a*), the Production and Cost Budgets a basis for (*b*), and (*c*) will be ascertained from the auxiliary department's budget.

Some foundries may be in a position to allocate the selling costs on a more accurate basis. For example, the sales department may be divided into sections, each section concentrating on a particular group of products, in which case the cost of operating each section would be charged to the particular products covered by that section.

Financial Budget

There are two sections to this budget: the profit and loss account and the balance sheet. The profit and loss account shows the probable cost of the year's working under the two headings of production cost and selling and distribution expenses. A summary of the various production and cost budgets made out for each department will provide the production cost figure, and the auxiliary departments budget will show cost of selling and distribution. The total sales figure as shown by the sales budget will be credited to the profit and loss account, and the difference between the two sides of this account will be the probable profit or loss for the period, after making adjustments for work in progress and opening and closing stocks.

The balance sheet is necessary to ensure that the financial position of the business is sound. It is an essential part of a budget system, as it ensures that a proper relationship is maintained between the expenditure and the income of the business. A balance sheet can provide valuable information on many points. For example, it can show:—

(*a*) Whether the business is overtrading, *i.e.*, whether the current assets are sufficient to cover current liabilities.

(*b*) The number of times the capital is turned over in the course of a year, *i.e.*, the ratio of annual sales to the capital of the business.

(*c*) The number of times the stock is turned over in the course of the year, *i.e.*, the ratio of annual sales to the value of stock normally held in the stores.

The illustration which follows contrasts the profits and capital turnover of two concerns in the same line of business.

At first sight A looks the more profitable business, but the ratio of profit to capital shows that the opposite is the case, while the ratio of sales to capital proves the value of a quick turnover.

	A.	B.
Sales for the year	£100,000	£100,000
Profit	£20,000	£17,500
Capital	£150,000	£90,000
Percentage profit to capital	13⅓ per cent.	19⅖ per cent.
Capital turnover	⅔	1⅑

(To be continued.)

American Notes

(FROM A SPECIAL CORRESPONDENT.)

Boron Determination in Ferrous Alloys

The increasing use of boron in the manufacture of metallurgical products, both as a scavenger and as an alloying constituent, has made desirable an accurate method for its determination when present in small amounts. A method for this determination is described in an article by JOHN L. HAGUE and HARRY A. BRIGHT, published in the Journal of Research of the U.S. Bureau of Standards. The procedure calls for solution of the sample in hydrochloric acid, followed by oxidation with hydrogen peroxide; distillation of methyl borate (Chapin's method); and titration of boric acid with sodium hydroxide in the presence of mannite. Selenium and tellurium do not interfere, but germanium, a very minor constituent rarely present in ferrous alloys, causes small positive errors. Directions are given for examining any acid-insoluble residue for boron. Data obtained by applying the method to a number of ferrous alloys show that results accurate to plus or minus 0.002 per cent. can be expected with irons and steels containing from 0.005 to 0.1 per cent. of boron.

* * *

Successful Sales Trailer

During the recent lull in business, the management of the Lake City Malleable Company, of Cleveland, Ohio, decided to equip its sales staff with a trailer sales display room in an effort to get new business. So encouraging were the results in the Cleveland area that the trailer has been routed for a tour of large markets throughout the United States. The interior of the trailer is lined with attractively-mounted displays of the company's products, of wooden patterns from which its castings are made, of castings in the unfinished state as they are sent to a customer for checking as to dimensions and specifications, and of a device for showing the tensile strength of its malleable iron

Surmounting Difficulties in Foundry Practice

By PAUL R. RAMP

The degree of difficulty involved in producing a casting is usually measured by the size of the casting, the size of the foundry and the type of equipment available. Take, for instance, the casting of a bridge block 60 by 60 by 12 in., weighing 5½ tons. This is a simple casting to mould, and in the average foundry would not present any unusual problems. However, in a small shop where the equipment is limited, casting this block becomes a difficult task.

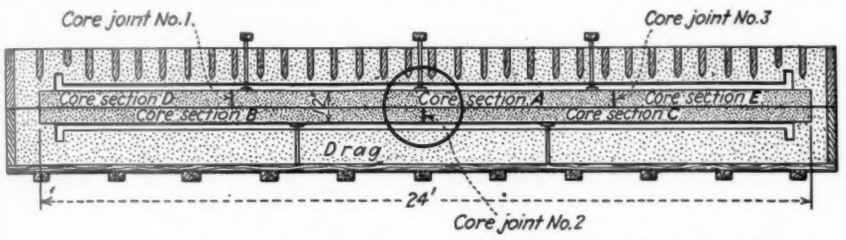

FIG. 1.—CROSS-SECTION OF MOULD, SHOWING METHOD OF SPLICING SHORT CORES.

A casting of this type has been made in a plant where the total melt was not over 9 tons a day. In casting this block the plant was confronted with the problem of feeding the mould after it was poured in order to secure a solid casting. When this job was first attempted, it was poured early in the heat, but long before the metal in the large feeding head was solid, the heat was over and no additional feed iron was available.

Cast-Iron Bars Used

To overcome this difficulty a number of cast-iron bars were put into the mould, supported

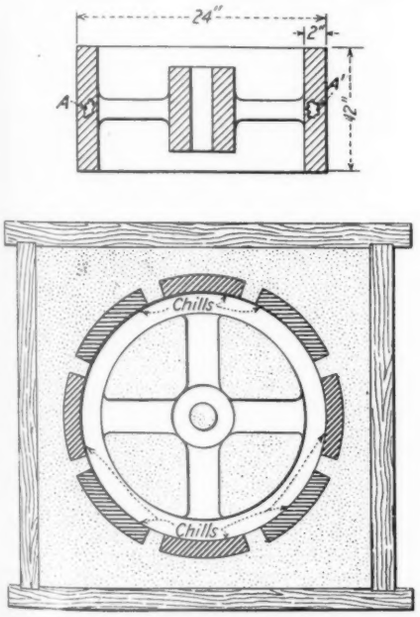

FIG. 2.—BULL GEAR SHOWING WHERE SHRINK HOLES OCCURRED AND WHERE CHILLS WERE PLACED TO ELIMINATE THEM.

by cast-iron chaplets, to lessen the amount of iron required to fill the mould. These bars were cast into open sand moulds and tumbled before putting in the mould in order to remove the sand. Space was reserved for whatever feeding could be done, and as long as liquid metal was available from the cupola the feeding head was kept filled. This trick made it possible to produce this casting without shrinkage.

A 22-ft. Pipe Casting

In another instance, a 22-ft. pipe, with a 12-in. inside diameter, was ordered from a small foundry. The customer furnished a full-length pattern and a 12-ft. half core box. Casting this pipe would not have been a particularly difficult task were it not for the fact that the customer specified that the inside of the pipe must be perfectly smooth *with no joints*. To produce this pipe with ordinary methods would require a 24-ft core. The foundry had no 24-ft. core plate and the job did not warrant a sweep core box.

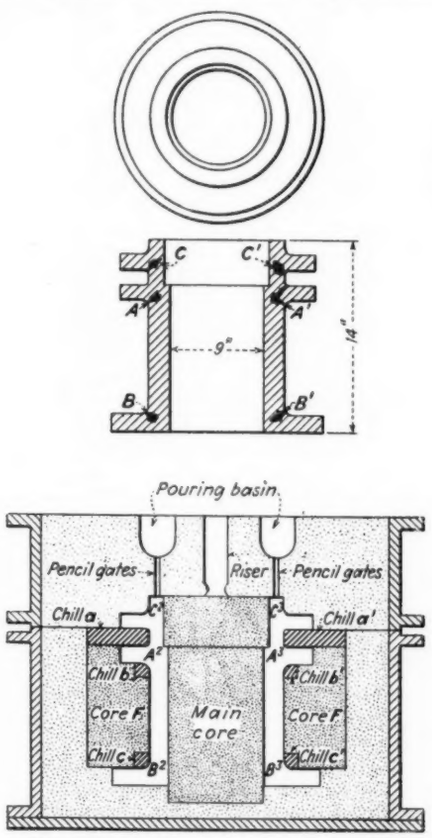

FIG. 3.—SPECIAL CASTING, SHOWING SHRINK HOLES AT FLANGE JOINTS AND CHILLS USED TO OBVIATE THEM.

The trick resorted to to produce the casting under these circumstances was a spliced core. Three half cores 12 ft. long, and two half cores 6 ft. long, were first made. Then two of the 12-ft. sections were butted together (see Fig. 1) and spliced by pasting and wiring the third 12-ft. section across the point where the first two cores joined. Fig. 1 shows this procedure in detail. Cores D and E in the drawing are the 6-ft. lengths, while cores A, B and C are the 12-ft. lengths. Apart from a little trouble in handling, the core was a success and produced a smooth inside surface.

Shrink Holes in Gears

A bull gear for a planer is an important casting, and any defects uncovered when the teeth are cut is objectionable and usually causes the rejection of the casting. The upper drawing in Fig. 2 shows where shrink pockets (A and A¹) often occur in this type gear. Losses caused by these defects can be reduced by using a close-grained metal with low phosphorus and low silicon. But a positive cure for these shrink holes is the use of chills as illustrated in the lower drawing in Fig. 2. This illustration shows the drag portion of a gear mould with sectional chills rammed against the face of the gear rim. It is not necessary that these chills be machined. The use of chills in this manner not only prevents shrink holes at the junction of the arms, but also produces a close-grained, long-wearing metal.

Some foundrymen use these chills at the arm junction only, but this is objectionable because in that case the character of the metal where the chills are used will differ from the metal at the points where no chill is used. The thickness of the chills should be three-quarters the thickness of the rim, and the chills should be covered with shellac or a chill coating. For best results the gears should be poured from the hub with hot iron.

"Ni-Resist" Pipe

The upper drawing in Fig. 3 is a special "Ni-Resist" casting similar to a heavy pipe. Little trouble would ordinarily be experienced in producing this casting if it were made of grey iron, but casting it out of "Ni-Resist" raised several problems. If moulded in the regular way and poured with "Ni-Resist" there are liable to occur shrink holes and pulling away at A, A¹, and at B and B¹. After the casting has been poured defects may also develop at C and C¹.

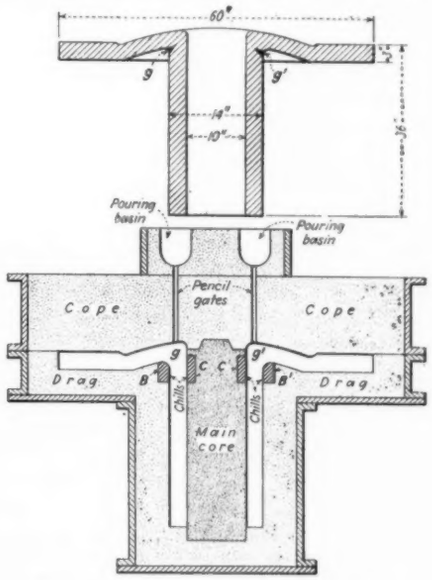

FIG. 4.—STEPS TAKEN TO PREVENT SHRINK-HOLE FORMATION IN A 60-IN. CYLINDER HEAD.

The use of chills as shown in the lower drawing in Fig. 3 will often eliminate these defects. Chills marked *b*, *b*¹, *c* and *c*¹ are placed in the core F when the core is made. Chills *a* and *a*¹ consist of two half-rings with sufficient taper to permit their easy removal from the casting after shake-out.

(*Concluded on page* 180.)

D

* This article originally appeared in the "Iron Age" under the title "Tricks of the Trade."

Investigation of the Time of Ramming Sand*

By Fr. BOUSSARD (Compagnie Générale des Conduits d'Eau, Liége)

PART I.—Influence of the Working Conditions on the Ramming of the Sand

In a Report submitted to the Brussels Foundry Congress in 1935, the qualities of a good ramming of the sand and also the means for effecting it were examined.[1] It was shown on that occasion how the shape of the rammer and its weight were of considerable importance in regard to the ramming time. The influence of the depth of ram was likewise pointed out.

When Papers on the moulding time are examined, bases or formulæ for determining the time to be allocated to each distinct operation of moulding are disclosed:—Preparation; filling; ramming; finishing; setting up the mould; pouring, etc.

These operations have been more or less detailed or grouped, according to the authors, and reference should be made to two important Papers on the "Moulding Time," the first that by Mr. Buffet,[2] relating to sand moulding in the pit with patterns for castings of more than 5 tons, and the second by Mr. Itam,[3] for smaller castings.

In these Papers, the various moulding operations are well detailed and bases for the calculation of the ramming time are also given.

According to Mr. Buffet's Paper, a distinction is made between:—

1. *Floor Ramming*, including the making of the intermediate beds of coke:

$$T/\text{hours} = V\ m^3 + 4.16.$$

V = volume of sand to be rammed, including the coke beds.

2. *Ramming in Boxes*: (*a*) Placing the gaggers in the upper box:

T/hours = 0.45 S m^3. S = surface of the box.

(*b*) Actual ramming:

T/hours = 6 V m^3.

V = volume of the box − volume of the casting.

3. *Free Ramming*, without gaggers or beds of coke and without any obstacle:

(*a*) By hand: T/hours = 3 V m^3.

(*b*) With the pneumatic rammer:

T/hours = 2.1 V m^3.

In his Paper, Mr. Itam considers ramming by successive layers of 50 mm. (2 in.) of sand (depth measured after ramming).

(*a*) *Ramming with hand rammer*:

Box.	Time of ramming one depth of ram.	
	Along the walls and cross-bars.	On the surface.
	Per second.	Per sq. decimetre.
Up to 250 mm. in depth ..	80 mm.	4 sec.
From 250 to 600 mm. in depth	60 ,,	5 ,,
From 250 to 600 mm. in depth with gaggers	40 ,,	10 ,,
From 600 to 1,000 mm. in depth	50 ,,	12 ,,
From 600 to 1,000 mm. in depth with gaggers	35 ,,	12 ,,

(*b*) *Ramming with the heavy hand rammer*:

For the top of the mould only, 2 sec. per square decimetre.

(*c*) *Ramming with the pneumatic rammer*:

For large boxes, without bars, for more than 35 square decimetres;

Taking up the rammer, 15 to 30 sec.;

Ramming two to three times quicker than by hand.

* Belgian Exchange Paper presented to the Seventeenth Annual Convention of the French Foundry Technical Association.

These data apply for a depth of rammed sand of 50 mm. corresponding to a depth of ram of 80 to 85 mm. of sand before ramming.

In Papers on moulding time, no consideration has generally been paid to the question of defining the shape and weight of the rammer, the intensity of ramming, and often even the depth of ram. In view of the considerable discrepancy which has been observed in the time taken to ram the same mould by selecting a certain depth of ram or a certain rammer rather

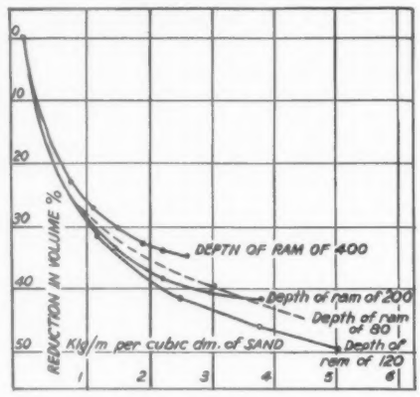

FIG. 1.—EFFECT OF RAMMER OF 4.9 KG. (10¾ LBS.) FALLING FROM A HEIGHT OF 300 MM.

than another, the Technical Committee of the Belgian Foundrymen's Association considered that these notions should be introduced in estimating the ramming time.

Factors of Importance for Ramming

It is proposed rapidly to pass in review the working conditions which may vary in the case of the ramming of sand, *viz.*, the depth of ram, the intensity of the blow of the rammer and the shape and weight of the rammer. To be able to judge the advantage of one method of working over another, only one factor will be varied at a time, all the other conditions remaining the

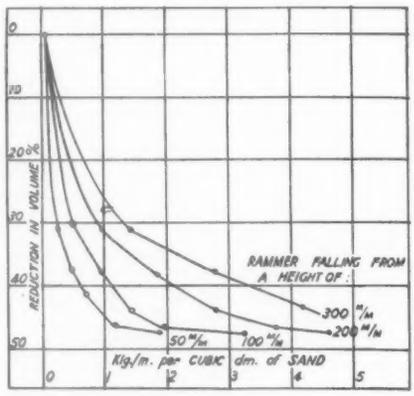

FIG. 2.—DEPTH OF RAM OF 80 MM. AND RAMMER OF 4.9 KG. (10¾ LBS.).

same, and the total work expended in ramming a cubic decimetre of sand will be measured each time.

(1) *Depth of ram.*

It is well known that less work has to be furnished for ramming sand by small depths of ram rather than by large depths of ram. This rule would be generally applicable if the blows of the rammer per square centimetre were fairly light. If the blow of the rammer was more powerful, there could be a lower limit in the depths of ram, below which ramming would again require a greater expenditure of work. This is the case shown in Fig. 1, where the depth of ram of 120 mm. (4.8 in.) appears to be the most advantageous.

(2) *Intensity of the Blows of the Rammer.*

For a given depth of ram and for ramming with the least expenditure of work, the blows of the rammer should be as light as possible, as is very well shown by Fig. 2. To facilitate the choice of the conditions for the most rapid ramming, two diagrams, Figs. 3 and 4, have been prepared which show, for depths of ram of 80 and 120 mm., the work to be furnished in kilogram-metres per cubic decimetre of sand to be rammed as a function of the intensity of the blow of the rammer per square centimetre.

Finally, since the man has to furnish the necessary work, it is likewise necessary to take into account the manner in which he is able to furnish this work. Fig. 5 gives, according to the weight of the rammer, the number of blows which a man can make per minute, and at the same time the work which he is able to furnish according to the weight of the rammer employed.

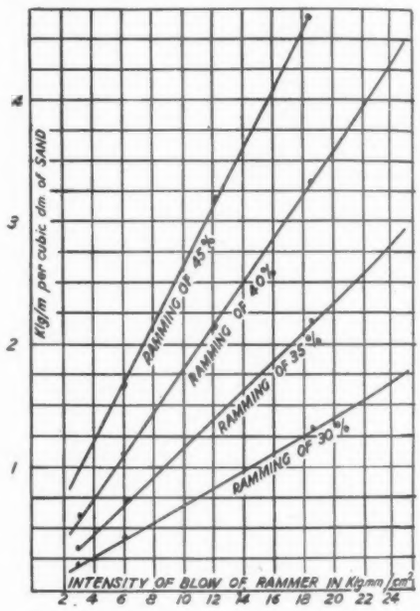

FIG. 3.—WORK NECESSARY FOR RAMMING 1 CUB. DM. OF SAND. DEPTH OF RAM OF 80 MM.

(3) *Choice of Rammer.*

The shape of the rammer, namely of rectangular section and therefore with a flat base (without any taper) being definitely adopted, its weight and section must be fixed. Table I gives the performances of rammers of various weights and sections for a ramming of 40 per cent. and for a depth of ram of 80 mm. Table I shows the influence of the weight of the rammer and principally of its (horizontal) section on the possibilities of ramming by one man.

PART II.—Ramming Time

These various working conditions being defined and their influences being known, ramming by means of two very characteristic rammers will now be considered. In view of the fact that certain factors sometimes act in opposition, it is first of all necessary to determine several points:—

(1) The shape of the rammer: of rectangular section.

(2) The dimensions and weight. It is proposed to consider a peg rammer having the dimensions

of the type commonly employed in the foundry, that is to say 50 mm. by 20 mm. (2 in. by 0.8 in.). It will therefore have a base of 10 square centimetres and its weight will be 1 kg. (2.2 lbs.). This is what may be called a small rammer, thought personally too small to be used continuously, but which is necessary, however, for reaching the parts where there is little space available.

A second rammer will correspond better to the conclusions made in the first part, and will be of larger dimensions without being excessively so. It will be 75 mm. by 40 mm. (3 in. by 1.6 in.), and will weigh 1.3 kg. (2.8 lbs.).

It has been noted that the moulder lifts his rammer to a height of about ten centimetres (2.4 in.). He does not, however, merely allow his rammer to drop, but throws it or presses on it during ramming, so that there is a certain increase in the intensity of the blow of the rammer. This leads to the introduction at this place of a coefficient of effectiveness, which amounts to saying that the blow of a rammer "thrown" from a height of 10 centimetres (4 in.) has the same available work as if it fell freely from 15 or 20 centimetres (6 in. or 8 in.) (the coefficient of effectiveness being 1.5 or 2 in this case).

This coefficient of effectiveness may vary from one man to another or sometimes even for the same man. It is therefore of interest to see what repercussion this coefficient of effectiveness has on the speed of ramming the sand.

Table II has been prepared with coefficients of effectiveness of 1.5, 2, 2.5 and 3 for both types of rammer, for depths of ram of 80 and 120 mm. (3.2 and 4.8 in.) and for ramming of 35 and 40 per cent. This table is full of practical information, because it takes into account the various rules previously found and gives the result of their application, a result which can be applied immediately in practice.

Initially there is the very appreciable difference in the times for ramming the same volume of sand 35 or 40 per cent. These times are approximately in the ratio of 2 to 3. This indicates that the sand must be rammed sufficiently but not excessively, because it takes longer and is not so good from the point of view of permeability.

Secondly, it is shown that for a depth of ram of 80 mm. (3.2 in.), the ramming time is not reduced even if the intensity of the blow of the rammer is multiplied by three. For a depth of ram of 120 mm. (4.8 in.), there is in this case a slight reduction in the time.

Finally it is particularly interesting to compare the two rammers with regard to the times taken. It is shown, for instance, that for the same ramming of 40 per cent., (*a*) with the rammer of 10 square centimetres, 9 sec. are required for ramming one cubic decimetre of sand, and (*b*) with the rammer of 30 square centimetres, only 3.2 sec. are required.

TABLE I.

DEPTH OF RAM, 80 mm. 40 PER CENT. RAMMING.

Rammer thrown from a height of 100 mm.

Plus the impulse (coefficient of effectiveness 1.5) = 150 mm. of free fall.

Area of the rammer head.		Weight of rammer.						
		0.5 kg.	1 kg.	1½ kg.	2 kg.	3 kg.	4 kg.	5 kg.
10 sq. cm.	Kilogram-millimetres per sq. cm...	7.5	15	22.5	30	—	—	—
	Kilogram-metres to be furnished per cub. dm.	1.37	2.6	3.7	4.6	—	—	—
	Cubic decimetres rammed per min.	8.5	7.5	7	6.4	—	—	—
20 sq. cm.	Kilogram-millimetres per sq. cm...	—	7.5	11.2	15	22.5	30	—
	Kilogram-metres to be furnished per cub. dm.	—	1.37	2	2.6	3.7	4.6	—
	Cubic decimetres rammed per min.	—	14.2	12.7	11.4	10.4	10.1	—
30 sq. cm.	Kilogram-millimetres per sq. cm...	2.5	5	7.5	10	15	20	25
	Kilogram-metres to be furnished per cub. dm.	0.45	0.9	1.37	1.75	2.6	3.3	4
	Cubic decimetres rammed per min.	25.8	21.2	18.6	16.8	14.8	14	13.4
40 sq. cm.	Kilogram-millimetres per sq. cm...	—	3.75	5.6	7.5	11.2	15	18.7
	Kilogram-metres to be furnished per cub. dm.	—	0.70	1.05	1.37	1.95	2.6	3.2
	Cubic decimetres rammed per min.	—	27.8	24.3	21.7	20	18	16.7
50 sq. cm.	Kilogram-millimetres per sq. cm...	—	3	4.5	6	9	12	15
	Kilogram-metres to be furnished per cub. dm.	—	0.6	0.8	1.1	1.6	2.1	2.6
	Cubic decimetres rammed per min.	—	32.5	32	26.8	24	22.1	20.6
75 sq. cm.	Kilogram-millimetres per sq. cm...	—	—	—	4	6	8	10
	Kilogram-metres to be furnished per cub. dm.	—	—	—	0.75	1.1	1.35	1.75
	Cubic decimetres rammed per min.	—	—	—	39.3	35	34.4	30.6
100 sq. cm.	Kilogram-metres per sq. cm. ..	—	—	—	3	4.5	6	7.5
	Kilogram-metres to be furnished per cub. dm.	—	—	—	0.6	0.8	1.1	1.3
	Cubic decimetres rammed per min.	—	—	—	49	48	42.3	41
	Kilogram-millimetres at each blow	75	150	225	300	450	600	750
	Available work, kilogram-metres ..	11.6	19.5	25.5	29.5	38.5	46.5	53.5

Comparison Between the Theoretical Calculated Times and Practical Tests

Ramming a box 540 by 360 by 150 mm. (21½ by 14½ by 6 in.) in two depths of ram of 120 mm. (4.8 in.) with the rammer of 30 square centimetres was effected as follows:

1st ram:

Filling with the shovel	11 sec.
Levelling the sand by hand ...	7 sec.
Giving 80 blows with the rammer	46 sec.

2nd ram:

Filling with the shovel	11 sec.
Levelling the sand by hand ...	7 sec.
Giving 80 blows with the rammer	46 sec.
Total	128 sec.

In this case, ramming occupies a time of 92 sec. and is 35.5 per cent. Theoretically, according to Table II, in this particular case (ramming of 35 per cent. rammer 30 square centimetres, depth of ram 120 mm.) it would be shown that the time of 2 sec. per square decimetre of sand to be rammed is required. The mould having a volume of 29.16 cubic decimetres, 45.6 cubic decimetres of sand are originally required; for ramming this box, therefore, it would be calculated that 45.6 × 2 = 91.2 sec.

It is now proposed to examine whether the author's figures agree with the investigations mentioned at the beginning of this Paper.

Considering a box 1,000 by 1,000 by 250 mm. (40 in. by 40 in. by 10 in.), *i.e.*, ¼ cubic metre:—

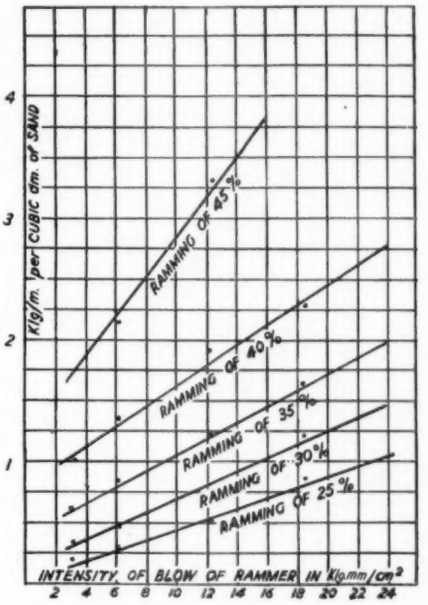

FIG. 4.—WORK NECESSARY FOR RAMMING 1 CUB. DM. OF SAND. DEPTH OF RAM OF 120 MM.

(1) *Mr. Buffet's Concepts.*

Here the case refers to free ramming without gaggers or obstacles. In this case, the formula was T/hours = 3 V cubic metres of rammed sand (volume measured after ramming).

The time allowed in this case would therefore be three times ¼ = ¾ hr. or 45 *min.*

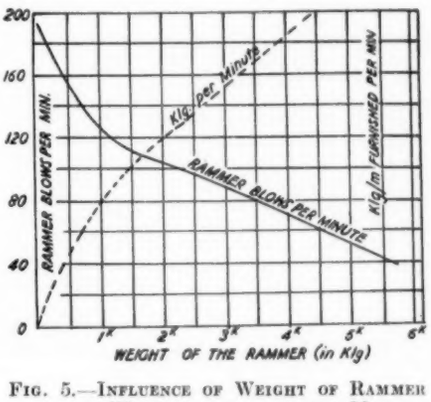

FIG. 5.—INFLUENCE OF WEIGHT OF RAMMER ON THE WORK FURNISHED BY THE MAN.

(2) *Mr. Itam's Concepts.*

Depth of ram of 50 mm. (after ramming). There will therefore be five layers.

For one ram there are:—

4 metres of walls at 80 millimetres per sec. = ...	50 sec.
1 square metre of surface at 4 sec. per square decimetre = ...	400 sec.
	450 sec.

Ramming time = 450 × 5 = 2,250 sec.

Filling time, 250 cubic decimetres × 1¾ sec. = 437 sec.

Total time, 2,687 sec. = 44.8 *min.*

3. *According to Table* II—

To provide ordinary conditions, a rammer of 10 square centimetres is assumed, associated with a depth of ram of 80 mm. and ramming of 40 per cent.

With these data, Table II shows that there will be absorbed

152 min. per cubic metre for ramming alone.
30 min. per cubic metre for filling.

182 min. in all, therefore 45.5 *min.* for ¼ cubic metre.

It is thus seen that, taking normal conditions, comparable results in all three cases are obtained. These figures may be considerably improved, however, by employing, for example, the 30 square centimetre rammer, which is not usual but which is advantageous. The times would then be:—

For ramming ... 53.5 min. per cub. metre.
For filling ... 30 min. per cub. metre.

Altogether ... 83.5 min. per cub. metre.

and for this moulding box a total of 21 min.

After numerous practical tests with a colleague on the Technical Committee of the Belgian Foundrymen's Association, Mr. Pirotte, who considered the problem from the point of view of the moulder, on whom ultimately devolves the responsibility for the soundness of the mould, it can be definitely asserted that, despite the larger rammer and its form without taper, the moulds rammed with this rammer of 30 square centimetres were all quite suitable. No inconvenience appeared in the necessarily rough handling by the overhead crane.

In conclusion, the advantage of employing, whenever possible, initial ramming with the feet and final ramming with the heavy rammer, will be shown.

Ramming with the feet:

On a *depth of ram of* 80 *mm.*, it is possible to effect in this way an initial ramming of 36 per cent. in 1 sec. for 3 square decimetres, or 7 min. per cubic metre.

On a *depth of ram of* 120 *mm.*, it is possible to effect an initial ramming of 26.5 per cent., in 1 sec. for 3 square decimetres, or 5 min. per cubic metre.

The advantage of the initial ramming with the feet will be appreciated when it is pointed out that, for attaining 35 per cent. of ramming with a depth of ram of 80 mm., 97 min. per cubic metre are required with the small rammer and 33 min. for the large rammer. This advantage is shown by some figures obtained for the time for one and the same moulding box (the figures are firstly for ramming and secondly for ramming and filling).

	Ramming alone.	Ramming + filling.
(1) Rammer of 10 sq. cm. alone (3 rams)	195 sec.	249 sec.
(2) Rammer of 10 sq. cm. and heavy rammer for the final ram	158 „	212 „
(3) Initial ramming with the feet at the commencement of each ram, then rammer and final ramming with the heavy rammer	136 „	190 „
(4) Rammer of 30 sq. cm. alone	114 „	168 „
(5) Rammer of 30 sq. cm. and final ram with the heavy rammer	110 „	164 „
(6) Initial ramming with the feet. Rammer and final ram with the heavy rammer	96 „	150 „

It should be noted that in this purely practical case, the method of ramming alone was pointed out to the moulder by way of indication, the remainder—depth of ram and number of blows—was left to his personal judgment, and yet the improvement is quite noticeable.

TABLE II.—*Theoretical Ramming.*

Time for ramming alone; for filling, 30 min. per cub. m. must be added.	Rammer of 1 kg. × 10 sq. cm.								Rammer of 1.300 kg. × 30 sq. cm.							
	Ramming of 35 per cent.				Ramming of 40 per cent.				Ramming of 35 per cent.				Ramming of 40 per cent.			
(*a*) Coefficient of effectiveness	1.5	2	2.5	3	1.5	2	2.5	3	1.5	2	2.5	3	1.5	2	2.5	3
(*b*) Theoretical height of fall in mm.	150	200	250	300	150	200	250	300	150	200	250	300	150	200	250	300
(*c*) Number of blows per minute	120	120	120	120	120	120	120	120	115	115	115	115	115	115	115	115
(*d*) Kilogram-metres furnished per minute	18	24	30	36	18	24	30	36	22.45	29.9	37.37	44.9	22.45	29.9	37.37	44.9
(*e*) Intensity of the blow in kilogram-metres per sq. cm.	15	20	25	30	15	20	25	30	6.5	8.7	10.8	13	6.5	8.7	10.8	13
Depth of ram of 80 mm.																
(*f*) Kilogram-metres to be furnished per cub. dm. (Fig. 2)	1.75	2.35	2.9	3.5	2.72	3.65	4.5	5.2	0.72	1	1.25	1.5	1.2	1.55	1.92	2.3
(*g*) Time in minutes for ramming 1 cub. m.	97.2	98	96.7	97.2	151	152	150	144	32.1	33.5	33.5	33.4	53.5	52	51.5	51.3
(*h*) Time in seconds for 1 cub. dm.	5.83	5.88	5.80	5.83	9.06	9.15	9	8.66	1.92	2	2	2	3.2	3.11	3.08	3.07
(*i*) Time in seconds for 1 sq. dm. of ram	4.66	4.70	4.64	4.66	7.25	7.32	7.20	6.94	1.53	1.6	1.6	1.6	2.56	2.49	2.47	2.46
(*j*) Blows necessary for 1 sq. dm. of ram	9.3	9.4	9.3	9.3	13.9	14	13.8	13.3	3	3.1	3.1	3.1	4.6	4.8	4.7	4.7
Depth of ram of 120 mm.																
(*l*) Kilogram-metres to be furnished per cub. dm.	1.375	1.72	2.04	2.4	2.05	2.5	2.87	3.37	0.81	0.96	1.1	1.25	1.35	1.50	1.70	1.87
(*m*) Time in minutes for ramming 1 cub. m.	76.5	71.7	68.1	66.7	114	104	96	93.5	36.1	32.1	26.8	27.8	60.3	50.1	45.5	37.5
(*n*) Time in seconds for ramming 1 cub. dm.	4.6	4.3	4.1	4	6.85	6.25	5.74	5.61	2.16	1.92	1.6	1.67	3.61	3	2.73	2.25
(*o*) Time in seconds for 1 sq. dm. of ram	5.52	5.16	4.92	4.8	8.23	7.5	6.9	6.73	2.59	2.31	1.92	2	4.32	3.6	3.28	2.7
(*p*) Blows necessary for 1 sq. dm. of ram	11	10.3	9.84	9.6	16.5	15	13.8	13.5	5	4.4	3.7	3.8	8.3	6.9	6.3	5.2

N.B.: $b = 100$ mm. $\times a$. $d = 1.000$ kg. $\times b \times c$. $e = 1.000$ kg. $\times b \div 10$ sq. cm. $f =$ read on Fig. 2 according to the intensity of the blow e.
$g = f \times 1{,}000 \div d$. $h = g \times 60 \div 1{,}000$ $i = h \times 0.8$. $j = c \times i \div 60$.

REFERENCES.

[1] "Le serrage du sable au fouloir" (Ramming of Sand), by F. Boussard, at the Brussels Foundry Congress, 1935.

[2] Paper read by Mr. Bernard Buffet to the A.T.F.F. on January 19, 1923, and communication to the Congress of Nancy "Le chronométrage en fonderie" (Timing in the Foundry).

[3] "Etude des temps de moulage" (Investigation of Moulding Time), by Mr. Itam ("Fonderie Moderne"), 1935.

Catalogue Received

Drop Forgings. A twelve-page well-illustrated brochure covering the productions of their drop-forging department has been received from Head, Wrightson, Limited, of Thornaby-on-Tees. A Keller die-sinking machine is a recent acquisition, and this is illustrated undertaking the task of machining a stub-axle die from a master pattern.

Blast Furnaces Restarted

The Shotts Iron Company, Limited, has restarted at its Shotts ironworks two blast furnaces which have been damped down since the middle of July. The by-product plant, which had been closed down, will also be restarted. This development means the re-employment of some 200 men who have been idle since the Fair holidays.

Surmounting Difficulties in Foundry Practice

(*Concluded from page* 177.)

In order to keep the hot metal from burning into the chills, pencil gates are used. When this type of mould is gated at the bottom, the chills are overheated and burned by the metal flowing over them while the mould is being filled. The use of pencil gates directs the metal in a manner to prevent the iron from coming in direct contact with the chills until the level of the metal in the mould reaches the level of the chills.

The upper portion of Fig. 4 is a cross-section of a 60-in. cylinder head. When this casting is produced from an iron containing a high percentage of nickel and chromium, shrinkage cracks often develop at g and g^1. Internal chills and heavy feed heads do not always eliminate these defects. However, the use of chills as shown in the lower half of Fig. 4 will usually clear up this trouble immediately. Sectional chills C and C^1 are rammed up in the main core and chills B and B^1 are rammed against the surface of the pattern.

The pencil gates shown in the drawing direct the metal past the chills while the lower portions of the mould are filling.

In making the heavy work-block shown in the mould in Fig. 5, considerable difficulty was experienced with the burning-in of the bolt slot cores (A). In order to ensure a clean surface on the bolt slot side of the casting, the mould was cast with the slot side in the drag. This put excessive pressure on the slot cores (A) and in order to produce a slot free of sand, cast-iron

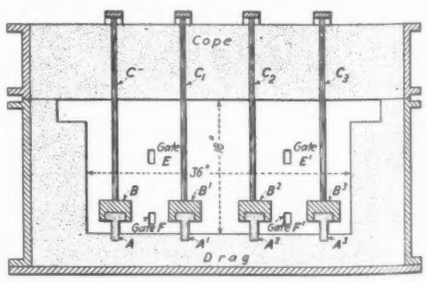

FIG. 5.—USE OF CAST-IRON SHROUDS TO PREVENT SLOT CORES BURNING IN.

shrouds were provided for the cores, as shown at B, B^1, B^2 and B^3. These shrouds were made in sections 12 in. long and were held in place by chaplets C, C_1, C_2 and C_3.

The pouring gate was arranged so that the first metal would run through gates F and F^1. After the cores were covered with metal the balance flowed through gates E and E^1.

Theoretical and Practical Significance of Graphitisation in Cast Iron*

By E. PIWOWARSKY (Aachen)

Grey cast iron is a material which has always occupied a noteworthy position among casting materials on account of its specific properties. Although its good fluidity ("life"), cheapness and good machinability are advantages the appreciation of which is as old as grey iron itself, yet it also possesses certain specific properties formerly esteemed and recognised unconsciously, but nowadays appreciated more and more consciously and on a scientific basis, and which, when properly utilised in combination with appropriate design, will ensure for grey iron for many years to come its preferred special position among casting materials, despite the keen competition of new materials on a light-metal or synthetic resin basis. These specific properties of grey iron include its wear-resisting capacity, its high compressive strength, its good vibration damping power, its high notch strength, its relatively high fatigue strength, its elastic resilience, its good corrosion-resisting properties, the good adhesion of its oxide and scale films, etc.

Correlation with Mechanical Properties

If all these specific properties of grey iron are considered in the light of the factors constituting their cause, it is easy to show that they are connected in some form or other with the presence of the graphite inclusions. As, however, the graphite inclusions weaken the coherence of the metal, this led to the two familiar methods of improving the mechanical properties of unalloyed grey iron by reducing the amount of graphite and also by producing the graphite inclusions in the most suitable form. In view of the fact that ways and means are now known for influencing graphitisation in normal-carbon cast irons in such a manner that its weakening effect on the mechanical strength is much less evident than was the case about twenty years ago, the question of the production of cast irons with a considerably diminished carbon content has become substantially less important.

As it is nowadays generally possible to produce sand-moulded cast iron systematically with 3.0 to 3.3 per cent. C and 1 to 2 per cent. Si and with wall-thicknesses of 10 to 30 mm. (0.4 to 1.2 in.), so that a test-bar corresponding to the mean wall-thickness has a strength of 15 to 17.8 tons per sq. in., or even 17.8 to 20.0 tons per sq. in. with carbon contents of 2.7 to 3 per cent. and 1.5 to 2.5 per cent. Si, while by employing special measures (melting of scrap, use of high-grade pig-iron, suitable metallurgical treatment, etc.), a strength of even up to 24 tons per sq. in. is attainable, it does not appear generally necessary to reduce the carbon content below about 2.7 to 2.8 per cent. for mechanically high-grade castings. Carbon contents of this order of magnitude with graphite contents of about 2 to 2.2 per cent. will then ensure the utilisation of the above-mentioned specific properties of grey iron without causing the foundryman serious difficulties with regard to the constructional form of the castings or melting and pouring.

Field for Low-Carbon Cast Iron

The production of cast iron with 1.5 to 2.5 per cent C only enters into consideration for special purposes (in particular cast iron which is to be subjected to a thermal after-treatment), where a particularly high strength at the expense of the other specific properties of grey iron appears to be expedient, having regard to the technical and industrial applications of the material. It is a well-known fact, however, that such cast irons have numerous casting and metallurgical disadvantages (poor mould-filling capacity, poor vibration damping capacity, increased shrinkage and porosity, lower machinability, etc.). In addition it has not yet been proved whether cast irons of this composition, in comparison with steel castings or forged steel on the one hand and with high-grade grey iron of normal carbon content on the other hand, really offer such practical advantages as to justify their increased manufacture or more extensive use.

The endeavours to improve the mechanical properties of grey iron for general engineering construction should, for the time being, terminate commendably with a maximum strength in special qualities of unalloyed and non-heat-treated grey iron of 21.5 to 24 tons per sq. in., which approaches or is equivalent to St 37 [a German structural steel specification], because high-grade grey iron should not replace but rather supplement other materials by virtue of its specific properties. Any further increase in the efforts solely in the direction of an increase in strength is only calculated to damage the foundry industry, to increase the costs of manufacture and to alienate the designer from one of the most valuable metal materials. This must be stated frankly, and a personal opinion is that it cannot be too forcibly emphasised among engineers and designers.

Finally, it is also well known, of course, that nowadays constructional and engineering materials should be appreciated, not so much on the basis of their static strength alone as from the point of view of the quality as determined by the purpose, a factor which is being recognised to an increasing extent in the official, *i.e.*, government, testing of materials. Existing knowledge of the relationships between static strength, fatigue strength and constancy of form permits conclusions to be drawn wholly in accordance with the above remarks.

Interpretation of Laboratory Tests

When practical men or scientists who are carrying out researches publish strength figures which far exceed the above-mentioned figures, their figures are generally the outcome of laboratory experiments which are primarily of service in developing cast iron *qua* material, but should not immediately give rise to corresponding demands being made by customers on the manufacturing concerns which, of course, have to make their castings under much more difficult conditions than is the case when single bars or very simple castings are cast with great care in the laboratory.

It is furthermore obvious that for many purposes where an unalloyed iron will serve, an alloy cast iron should not be stipulated. In addition, the meaning of [the German] Standard Specification 1691 is often entirely misunderstood by customers, especially with regard to engineering castings based on special prescriptions as to quality. The minimum values laid down in the standard specification for the various grades of quality relate to separately-cast test-bars, the diameter of which is adapted to the mean wall-thickness of the castings and which generally should not exceed 30 mm. (1.2 in.). It is obvious that it is quite unreasonable for customers, as has actually occurred already, to stipulate that the strength—for instance, the tensile strength—corresponding to the particular grade of quality, should exist in all parts of the casting, even at the weakest places, for instance in the vicinity of the pouring gate.

Such an entirely irrational interpretation of the standard specification would mean, for instance, that in order to ensure a strength of 16.5 tons per sq. in. in all parts of a casting, the cast test bar would have to have a strength of 22.2 to 25.4 tons per sq. in. It would be much more correct and rational if the stipulations were to extend to limiting the permissible minimum figures at those points of the casting where there is a tendency to porosity, etc., thereby obliging the foundry to take every precaution for producing an iron of the lowest possible wall-thickness sensitivity. Exaggerated demands for excessively high strengths, however, by no means afford a guarantee of the quality of the casting as determined by its purpose.

Major Field

It follows from the above that for the grey iron founder, the cast irons with 2.7 to 3.4 per cent. C are and should remain the most important from the point of view of manufacture and use. Within the range of these limits, the foundryman, of course, has to secure from the grey iron the best of the properties of the kind desired in each particular case. He must endeavour to learn to control the metallic matrix and the form of the graphitisation so as to obtain the best properties with the minimum cost of production and waste.

Fundamentally, as is well known, the control of the metallic matrix is effected on the basis of the available cast iron diagrams and numerous special measures employed, for instance, in the production of Krupp's "Sternguss" iron, Emmel iron and in the Lanz process. It must also be borne in mind, however, that the type of furnace, superheating of the molten metal, pouring temperature and moulding, casting and gating technique exert their various influences. Regarding the superheating of the molten metal, it is known that its rational application, in addition to the well-known Schüz casting process, was the first serviceable method of systematically influencing the graphitisation in sand-moulded eutectic or nearly eutectic irons.

Even though low-carbon irons have an increasing tendency, with increasing superheating of the molten iron above about 1,400 deg. C., to exhibit an increase in the fineness of the graphite with local accumulation of graphite around the primary mixed crystals, one is nevertheless in a position even in these cases to make use of the advantages of superheating the molten metal by deoxidising or inoculating ladle additions, suitable control of the slag, supervision of the pouring temperature, and so forth. Even in cast irons having what is called a pseudo-eutectic structure, however, strengths of 23 to 25.4 tons per sq. in. may be observed with 2.7 to 2.8 per cent. C. With regard to fluidity ("life"), vibration damping capacity, reduction of blow-hole formation, porosity phenomena, however, low-carbon irons should be superheated to a sufficiently high degree in each case. Actually, that is what is done in practice with good results.

Ladle Additions and Slag Control

Concerning deoxidising ladle additions in the form of ferro-silicon or aluminium alloys, the author observed in 1927-28, in electric furnace melts, a fairly constant increase in the strength figures (4 to 6 kg. for the transverse strength), a corresponding reference to which is also to be found in "Hochwertiger Grauguss"* (Verlag Springer, 1929, page 134). Under slags rich in lime or alumina, and with considerable superheating of the bath in the electric furnace, it is quite possible to attain tensile strengths of

(*Continued on page* 184.)

* Extract from an address given at the Seventh Colloquium of the Aachen Foundry Institute and translated from "Die Giesserei."

* "High-Grade Grey Cast Iron."

Underground Corrosion of Pipe*

ITS CAUSES AND SOME SUGGESTED REMEDIES

By K. H. LOGAN (National Bureau of Standards, Washington, D.C.)

Underground corrosion has been studied chiefly from the point of view of the operators of pipe lines and pipe net-works because of the great extent and value of such installations. The operator of an industrial plant who has an underground corrosion problem can learn much through a study of the literature dealing with the corrosion of pipe lines. He will find, however, that his problem is somewhat different from that of the pipe-line operator both as to the relative importance of the possible causes of corrosion and as to the methods of mitigation which may be employed. This may be better understood by a brief review of the conditions which favour underground corrosion.

Causes of Corrosion

Without going back too far in a search for causes of corrosion, it may be stated that many conditions create differences in electrical potential between small areas on a buried metallic structure and other areas on that or an adjoined structure. There is a tendency for the establishment of an electrical equilibrium just as there is a tendency for water to reach an equilibrium.

In the establishment of the electrical equilibrium charged particles of the metal, cations, move out of the metal at a point of high potential and migrate toward a point of lower potential. This is the first step in the corrosion process. The seriousness of the corrosion depends on the number of migrating particles which leave the metal in a unit time and on the duration of the process. The latter depends largely upon what happens to the migrating particles, *i.e.*, upon secondary reactions at the anode or corroding area and at the cathode or receiving area. Incidentally, it should be mentioned that under most conditions the cathodic area is protected against corrosion. These differences of electrical potential may be set up by many differences in states or conditions of two points on the surface of the buried metal or in the soil solution which surrounds different parts of the metal.

Specifically, differences of potential are created when one metal is connected to another, as when a brass service cock is screwed into an iron pipe or tank, when mill scale is removed from one point on the tank while it remains at another point, when a pipe passes from one type of soil to another, when the soil is not homogeneous as is the case with filled ground, when oxygen can reach one part of the surface of a metal more readily than some other part, or when a pipe picks up stray current at one point and discharges it at another.

Interpretation Difficulties

The conditions under which differences of potential occur are so numerous that with a sufficiently sensitive instrument one is almost sure to find them wherever the apparatus is set up. The problem is therefore not the finding of possible causes of corrosion but the evaluation and interpretation of the differences of potential which are discovered, for, while the difference of potential may indicate a possibility of corrosion, the amount of corrosion is affected by other factors. The almost universal practice of using a brass corporation cock for connecting water-service pipes to cast-iron mains is a good example. The difference of potential between brass and iron or steel may be several tenths of a volt, but under most soil conditions the corrosion of the iron due to the brass cock is distributed over such a large area as to be unimportant. In other cases the products of corrosion which collect on the brass or the iron reduce the corrosion to a negligible quantity. Under some conditions, however, the interconnection of brass and iron results in serious corrosion.

Corrosion around Industrial Undertakings

A brief discussion of a few of the cases of corrosion associated with industrial plants which have come to the attention of the writer may illustrate the variety of the corrosion problems which may arise in such plants. One plant consisted of a number of scattered buildings which were heated by a central steam-heating unit. The 1¼-in. special cast-iron steam return lines began to fail within 18 months of their installation. There was no possibility of stray-current electrolysis, and tests of samples of the soil indicated that it was not corrosive. Long-distance diagnosis of such troubles is likely to be unreliable. However, since only the return lines corroded, it is apparent that the cause of the corrosion is associated with some difference in the conditions of the two lines.

A plausible explanation is that the return lines were not hot enough to keep the soil dry but were sufficiently hot to melt the snow which was above them during the winter, and thus to establish a condition around parts of them of warm, wet earth which is particularly favourable to corrosion. This may have been augmented by the galvanic potential between the pipe in the wet earth and that of the steam pipe surrounded by earth which was kept dry by the hotter pipe.

A large chemical plant was troubled by corrosion of its water main near a storage house. The ground was found to be contaminated by sulphates swept from the house or spilled when these materials were loaded or unloaded.

The fire lines of a refinery corroded rapidly. Inquiry developed the fact that the plant was located on the edge of a marsh, the pipes being embedded in a muck soil occasionally flooded by brackish water. This is an ideal condition for corrosion.

Corrosion in Ferro-Concrete

A reinforced-concrete packing house was built across the alley from a public-tramway power house. Within a few years the concrete began to spall from the reinforced beams and columns in large pieces. The presence of small currents was detected on the pipes within the building and on the reinforcing metal and suit was brought against the tramway company. Investigation disclosed the facts that salt was added to the concrete to keep it from freezing while the building was under construction and that the second floor of the building was occupied by large vats used in the preparation of corned beef during which considerable water was spilled on the floor. Since the corrosion was not confined to places where the current might leave the reinforcing material for some other conductor, it is highly probable that the corrosion was attributable to the salt and the water.

The locating and remedying of corrosion troubles when they are serious can be done most economically by a specialist thoroughly familiar with such work. An attempt to take care of the trouble by one with little experience may result in subsequent losses that may cost much more than the charges of a competent consulting engineer. Certainly, anything that can be written without specific knowledge of the local conditions must be of uncertain value to the plant superintendent who has a serious corrosion problem, because of the large number of possible causes of corrosion. However, there are cases in which the employment of a consultant is impracticable or prohibited by the management. The following suggestions are therefore offered for the use of those who must, because of circumstances, attempt to solve their own corrosion problems.

Curing Corrosion Troubles

Obviously, the logical start in curing corrosion troubles is to locate the cause. The two causes which almost invariably are thought of first are: electrolysis and inferior materials, since these allow the owner to shift the responsibility from his own shoulders. Electrolysis has long been the standard alibi of the pipe manufacturer. The abandonment of tramway systems in many cities, however, has made the use of this overburdened explanation more difficult.

Stray-current electrolysis is in most cases easily recognised, because it is confined to localities having direct-current systems with ground or grounded return circuits, and because the currents can be recognised by their fluctuating nature. Usually, electrolysis is associated with tramway systems, but the writer recalls an instance of electrolysis which apparently was the result of using a ground return for a welding outfit in a shipyard.

The shape of the record obtained with a sensitive recording millivoltmeter, connected in parallel with the corroded pipe, is often helpful in locating the source of the trouble. In any event, if the instrument indicates a steady current or one which changes but slowly, it is improbable that stray currents caused the corrosion. Even if a fluctuating current is found, it must be proved that current leaves the pipe at the corroding area before it can be concluded that the current is the cause of the corrosion. The presence of current on a conductor does not cause it to corrode.

Precautions to be Taken

In the measurement of small currents it is necessary to take special precautions to avoid thermal e.m.f. and galvanic potentials. With proper care and instruments, however, it is possible to measure the current on each side of the suspected point of discharge and to measure the current in the earth adjacent to the corroding area. However, since current will be found to be leaving the corroding area in case of either galvanic corrosion or stray current electrolysis, and since current which merely flows across the pipe may occasionally be found in the earth, additional tests will be required to determine the nature and source of any observed current. The nature of these tests will depend on local conditions.

To prove that the corrosion is the result of inferior material is in most cases even more difficult than to prove that corrosion was caused by stray currents. Microscopic examination of the metal will determine whether the structure is normal at the point examined, but the destruction of the metal at the point of failure is usually so nearly complete that, if imperfect material existed, evidence of it has been lost. In any event, only isolated cases of failure due to poor material should be expected, and the cost of establishing the fact that imperfect material was used may easily exceed the cost of repairs.

Imperfections

Segregations in alloys, inclusions of slags or cinder and other imperfections set up potential differences which result in corrosion, but there are many other sources of equal or greater potential differences. If the failing pipe was purchased from a reputable firm, the question of inferior material is scarcely worth considering. This conclusion is strengthened by the fact that under most soil conditions, the rates of corrosion of the commonly used pipe materials are controlled by soil conditions rather than by the composition or structure of the material. Only in cases where high-alloy steel or non-ferrous materials

* Reproduced from "Chemical & Metallurgical Engineering."

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of relatively high price were specified is it likely to be profitable to inquire into the nature of the corroding pipe.

Soil Tests

Most cases of underground corrosion are the result of corrosive soils or soil conditions. In general, soils which are poorly drained, soils which contain organic or other acids, and soils high in salts are corrosive. Serious corrosion seldom occurs in well-drained soils having high electrical resistivity and high *p*H values. Many soils will be found to contain some characteristics tending to indicate that they are corrosive and other characteristics which suggest that they should be non-corrosive. Thus, a soil may have high resistivity and high acidity, or high *p*H value and high salt content.

A number of tests for soil corrosivity have been developed which are satisfactory for certain classes of soils or for the soils in a certain region. Few, if any, of them are entirely successful in identifying all corrosive soils. At best, a determination of the corrosivity of a soil will tell only whether or not the soil as a type is corrosive. It cannot be depended on to tell whether corrosion of a particular spot was caused by the soil, although in many cases the indications of the test may be correct. This should be obvious from the fact that, even in an apparently uniform soil serious corrosion is very localised. The corrosion is influenced by the contact between the pipe and the soil and by other factors in addition to the characteristics of the soil in which the corrosion occurred. In most cases of corrosion the investigation of the soil to determine whether it is corrosive is superfluous. The fact that the pipe corroded in the absence of conditions favourable to stray current electrolysis and that imperfections in the material are not obvious, are in themselves satisfactory evidence that the soil is corrosive.

When the first leak occurs in a pipe on the property of an industrial plant, it is advisable to examine pipes in a few other localities in the plant to determine whether or not the failure is accidental. If a number of leaks have occurred or if the pipe system is found to be corroded at a number of points, it is obvious that some action should be taken. As was said, if the corrosion is general and serious, the best course is to call in a consulting engineer. If this cannot be done, determine roughly whether stray currents are the probable cause. This is improbable, though not impossible, except in plants near tramway power plants and substations. If tramway current is found to enter the plant on one or two lines, insulating joints in the lines may stop the corrosion.

Cathodic Protection

Protection against electrolysis may also be secured by lowering the potential of the pipe networks at the plant by means of a superimposed current. This is known as cathodic protection and will be mentioned again.

Soil conditions are the most frequent causes of corrosion. In such cases two courses are open: the use of corrosion-resistant materials and the use of protective coatings.

The differences in the rates of corrosion of the commonly-used pipe materials when exposed to the same soil are not great, and if one fails within a short time the others cannot be expected to last enough longer to provide a satisfactory solution to the corrosion problem. Alloys of iron high in nickel or in chromium and nickel are very resistant to most soils, as is iron containing more than 14 per cent. of silicon. Copper and alloys containing a high percentage of copper are much more resistant to corrosion than the commonly-used ferrous materials and will probably prove satisfactory except in cinder fills and soils high in sulphides. Lead pipe is very satisfactory in many corrosive soils, especially those containing sulphates, but lead pits badly in a few soils. Among the soils corroding lead is allis loam, a soil formed from a blue shale. The lead-coated pipe tested by the Bureau of Standards has not proved as generally satisfactory as galvanised pipe, perhaps because of the thinness of the lead coating.

The conditions under which galvanised pipe are unsatisfactory have not been fully determined, but it has been shown that the weight and uniformity of the coating are important factors. Users of galvanised sheet and pipe should specify the weight of coating which they desire.

Protective Coatings

In many cases it may be more economical to protect a pipe network than to construct it of corrosion-resistant material. It is not difficult to protect parts of a pipe line temporarily. To provide permanent protection for all of a pipe line or network is much more difficult. There is evidence which strongly suggests that under some conditions an imperfect coating may accelerate pitting, although it reduces the total loss of metal.

The type of protection which should be used depends partly on whether or not the pipes can be removed from the ground. If the corroded pipe is of cast iron with bell and spigot joints, or if for any reason the pipe cannot be raised from the trench to a position where it can be cleaned and thoroughly dried, it is not advisable to apply a bituminous coating. It is possible to apply an asphalt emulsion to a moist pipe, but tests with which the writer is familiar indicate that such coatings do not afford satisfactory protection against severely corrosive soils. Greases can also be applied to pipes that are not dry, if they are clean. Under wet soil conditions grease coatings have afforded very considerable protection to pipes over periods of approximately nine years. It is desirable that the grease be reinforced or shielded by a wrapper, preferably of asbestos felt.

This, of course, requires the removal of the pipe from the trench. If the pipe cannot be removed from the trench, probably the best protection will be afforded by removing the earth and corrosion products from all sides, blocking up the pipe by means of non-porous supports, such as glass or vitrified clay, and surrounding it by one or two inches of concrete or cement mortar. To do this, it is necessary first to surround the pipe by a form. The concrete should be poured on one side of the pipe only and tamped until it rises on the other side. This prevents the formation of voids on the under side of the pipe. Removable metal forms may be constructed, but for small jobs forms built of cheap timber which can be left in the trench may be cheaper.

The most extensively used coating for pipe lines is a bituminous enamel reinforced in very corrosive soils by a fabric. Hand application of these enamels is not altogether satisfactory, and machine application at the trench is not well adapted to small jobs. On this account, coatings applied at the rolling mill when the pipe is made are probably more suited to industrial plant installations. If these are used, it will be necessary to protect the joints after the pipe sections are connected.

It is difficult to secure a continuous coating free from pinholes, thin spots, and abrasions. Such defects sometimes result in accelerated corrosion by pitting. The evil effects of the defects may be overcome by applying cathodic protection to the line. This consists of connecting the negative side of a low-voltage source of power such as a battery charger to the pipe and the positive side to a suitably placed set of anodes such as carbon rods on junk pipe. If the coating is perfect no power will be consumed, but usually a small current will flow. Details of the installation of a system of cathodic protection cannot be given in a short Paper, but the reader will have little difficulty in finding literature on this subject.

Remedies for Corrosion

Cathodic protection is equally suitable for preventing electrolytic corrosion of coated pipe lines. If the lines are bare, more current will be required and the probability of securing complete protection somewhat less.

Since it has been observed that a protective carbonate film is sometimes formed in limestone soils, the addition of slaked lime, calcium hydroxide, to acid soils has been suggested. It seems probable that this will be most effective in well aerated soils. Some poorly drained soils containing lime are quite corrosive. It is not uncommon to backfill trenches traversing filled ground with clear sand or clay. Either will, of course, prevent the corrosive filled-in material from contacting the pipe, but the sand will allow any corrosive solutions to reach it. Some clay soils are quite corrosive. It is apparent, therefore, that these remedies should be used with discretion.

The mitigation of underground corrosion at an industrial plant is largely a matter of choosing the measure which best fits local conditions. Only the man on the job can make the proper selection. Some of the methods from which he may choose have been outlined above.

Theoretical and Practical Significance of Graphitisation in Cast Iron

(*Concluded from page* 181.)

19 to 24.5 tons per sq. in. with carbon contents of 3 to 3.2 per cent. In agreement with the investigations of L. Treuheit and E. Diepschlag ("Die Giesserei," 1931, page 705) concerning the influence of slags rich in lime and alumina on the properties of cast iron, it is also possible, as is well known, to produce in the blast furnace a special high-carbon pig-iron with graphitisation of considerable fineness (Lübeck HK-iron), which, like the Migra iron produced by superheating, is stated to be capable of imposing on the remelted iron a graphitisation of greater fineness with correspondingly valuable properties. Information of value concerning the influence of oxide slag or oxide-free furnace slags is contained in the Papers by W. O. Ruff (Thesis, Brunswick, 1932) and P. Bardenhauer and A. Reinhardt (Mitt. Kais. Wilh.-Inst., Düsseldorf, 1936, No. 6). According to these authors, low-oxide silicate slags, particularly in the case of low-carbon melts, promote the formation of an exceedingly fine graphite eutectic, while slags richer in oxide tend to produce normal crystallisation of the graphite without excessive supercooling.

Conclusion

Cast iron with 2.7 to about 3.3 per cent. C are still the most important alloys for the considerable practice employing grey iron. Users should pay more regard than heretofore to the fact that important specific properties of cast iron are related to the presence of a certain amount of graphite. A natural limit is thus imposed on stipulations made from the point of view of strength figures alone.

Catalogue Received

Smiths' Hearths and Small Electric Blowing Fans. An essentially utilitarian catalogue, V97, which is really a sectional one, has been prepared by Keith Blackman, Limited, of 27, Farringdon Avenue, London, E.C.4, and well covers this subject. From a perusal of the contents, it becomes evident that much thought has been given to these almost essential pieces of equipment, and now one has a choice between battery or individually-blown hearths, whilst improved smoke-exhaust plants are also featured. The choice is bewilderingly wide—there are fixed and portable up and down drafts for angle-smiths, coppersmiths, and all the rest of the light forging fraternity.

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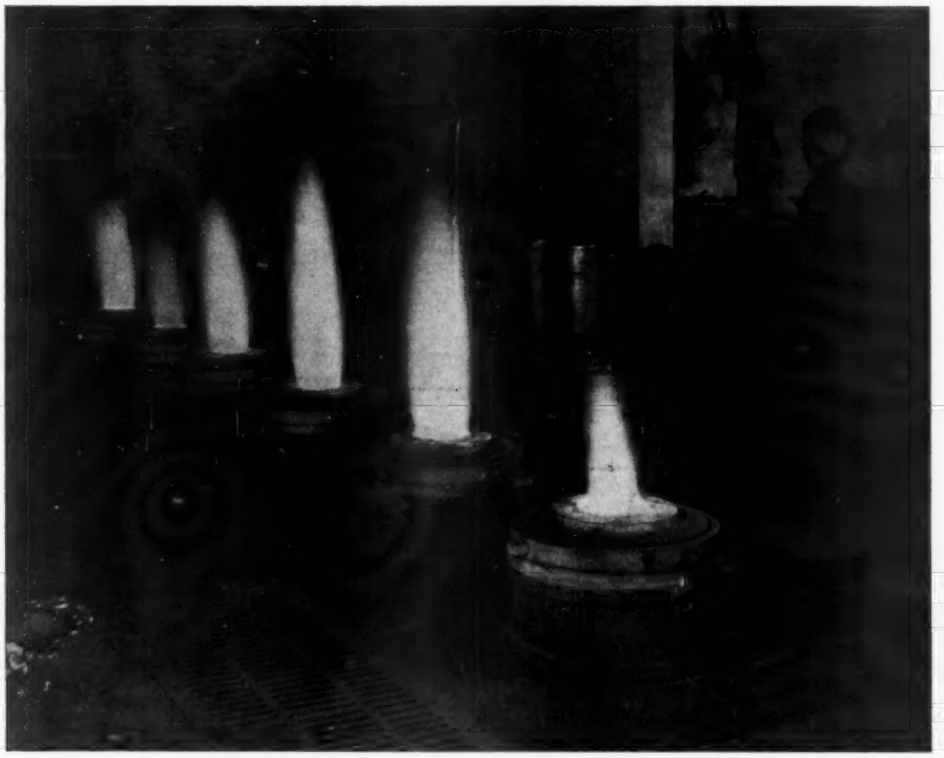

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The Week's News in Brief

Trade Talk

AN ORDER for twenty more railcars has been placed by the Great Western Railway to supplement its existing fleet.

THE ANNUAL CONFERENCE of the Institute of Quarrying will be held at Dunblane, Scotland, from September 12 to 15.

THE GREEK GOVERNMENT has confirmed a £2,250,000 contract for land reclamation by Henry Boot & Sons, Limited, of Sheffield.

A FRENCH DECREE prohibits the export from France of tungsten steel products, croppings, or scrap irrespective of type. Re-exports are also prohibited.

A NUMBER OF MOULDS were ruined and some damage done to walls and roof when fire broke out last Thursday at the East Kent Iron Works, Sittingbourne, Kent.

EMPLOYEES OF the Scottish Enamelling Company, Limited, have opened a new football ground. Through the kindness of the directors the team, Seco Rangers, are starting off the season free from debt.

N. V. VAN LEER'S WALSGEDRIJVEN, Amsterdam, has been registered in Holland with a capital of 500,000 fl. The company proposes to establish rolling mills for the manufacture of flats, bars and shapes, etc.

FACTORIES IN ALL PARTS of the country are overhauling their existing lighting systems to comply with the Factories Act, which came into operation on July 1, and lays down that: "Effective provision shall be made for securing and maintaining sufficient and suitable lighting, whether natural or artificial, in every part of a factory in which persons are working or passing." In this connection the British Electrical Development Association and the Electric Lamp Manufacturers' Association are offering free facilities to factory owners for the expert testing of existing lighting and free guidance for any alterations required.

Obituary

MR. HAROLD J. BIGGIN, a director of G. Tucker & Company (Sheffield), Limited, iron, steel and metal merchants, died recently, aged 59.

MR. ALEXANDER BROWN, a foreman in Lane & Girvan's foundry at Bonnybridge, collapsed and died whilst at work on August 30.

MR. G. MARKS, a director of Beyer Peacock & Company, Limited, and of the Coal & Iron Trades Insurance Company, Limited, has died at the age of 73.

MR. M. S. STUTCHBURY, a director of the Thames Metal Company, Limited, tin smelters, and Metal Traders' Technical, Limited, of Gracechurch Street, London, has died at the age of 58.

MR. WILLIAM FORSTER HINDSON, who has died at Redcar, aged 70, was chief draughtsman at the Whessoe Foundry & Engineering Company, Limited, Darlington, with which he had been associated 34 years.

MR. W. RUSSELL, of Stockton-on-Tees, a director and secretary for many years of R. W. Crosthwaite, Limited, ironfounders, Thornaby-on-Tees, has died at Stockton. For some years he had been living in retirement.

MR. THOMAS LENNOX POOLE, who received the O.B.E. for his conduct on the occasion of the explosion, towards the end of the Great War, at the Low Moor Iron Company's works, has died. Mr. Poole was blast-furnace manager at the Low Moor works during the War, and adjacent to the works was a large munition factory. This was the scene of a violent explosion, which caused panic to break out among the workpeople. Mr. Poole, however, stuck to his post, safeguarding his plant, in spite of the fact that the part of the factory in which he was at work was seriously affected by the explosion. Mr. Poole began his career with Robert Heath & Sons at their ironworks at Ford Green, and later he became manager for the Low Moor Iron Company, Limited.

New Master Cutler

Mr. A. J. Grant, managing director of Thos. Firth & John Brown, Limited, was elected Master Cutler at a meeting of the Cutlers' Company in Sheffield on August 31. He will be installed in office on October 4. Mr. Grant has for the past year been Senior Warden of the Cutlers' Company. Besides being managing director of Thos. Firth & John Brown, Limited, he is chairman of Firth-Vickers Stainless Steels, Limited, and chairman of the Firth-Brearley Stainless Steel Syndicate, Limited. He was President of Sheffield Chamber of Commerce last year. After several years at Birkenhead with Laird Bros. and other firms with shipbuilding connections, Mr. Grant went to Sheffield in 1911 to take up an appointment with John Brown & Company, Limited, as assistant to the managing director. Four years later he became a local director, and in May, 1919, a director of the

MR. A. J. GRANT.

firm. At the end of 1928 he was appointed managing director of the Atlas Works, succeeding Sir William Ellis. He joined the board of Thos. Firth & Sons, Limited, in July, 1930, and, on the amalgamation of the Atlas and Norfolk works, became joint managing director. Among other positions which he holds are directorships of Cravens Railway Carriage & Wagon Company, Limited, and the Park Gate Iron & Steel Company, Limited. Mr. Grant was elected President of the National Federation of Iron and Steel Manufacturers in 1932, and was leader of the British Iron and Steel Delegation at the Ottawa Conference. In 1934 Mr. Grant was chosen to represent the Sheffield district on the new Council of the British Iron and Steel Federation. He is a member of the Council of the Federation of British Industries and for three years was President of the Sheffield branch of the National Union of Manufacturers.

Company Reports

Quirk, Barton & Company, Limited.—Interim dividend of 2½ per cent.

Cochran & Company (Annan), Limited.—Final dividend of 5 per cent., tax free, making 7½ per cent., tax free.

Kay & Company (Engineers), Limited.—Final dividend of 10 per cent., making 20 per cent. for the year ended May 31 last.

Partington Steel & Iron Company, Limited.—Net profit for the year to June 30, £89,874; brought in, £924; payment of 6 per cent. on the income debentures, £41,425; set aside for securing income debentures, £40,000; debit balance at June 30 last, £55,746.

Will

SMITH, H. F., of Birmingham, chairman and managing director of Smith & Davis, Limited, brassfounders ...	£52,154

Imports of Pig-Iron into the Argentine

The Department of Overseas Trade has issued a Report* on Economic and Commercial Conditions in the Argentine Republic, by MR. S. G. IRVING, Commercial Counsellor, His Majesty's Embassy, Buenos Aires, from which the following extract relating to the imports of pig-iron are taken.

Pig-Iron

Towards the end of 1936 the U.S.S.R., the leading supplier of pig-iron at the time, suddenly decided to send no further consignment stocks, and the local railway companies' holdings of old iron sleepers being needed by the companies themselves, 1937 opened with the market almost bare of supplies. With the advent of rising prices, many orders were released and imports rose from 26,721 tons in 1936 to 52,106 tons in 1937. Such a rate of expansion was, however, out of all proportion to the needs of the foundries, which, consequently becoming overloaded with stocks, curtailed their orders towards the end of the year. The bulk of the demand was met from France, on the basis of £5 per ton, c.i.f. Buenos Aires, as compared with a United Kingdom price of about £8 per ton. Notwithstanding this large difference, there is a steady demand for United Kingdom pig-iron for better-class work on account of its superior quality, the French and Belgian products being used mainly for ordinary foundry work.

Contracts Open

Bollington, September 19.—Providing, laying and jointing of 5,500 yds. of 3-in., 4-in., 5-in. and 7-in. dia. iron pipes, with valves, hydrants and other fittings; also construction of two concrete service reservoirs, for the Urban District Council. Brady & Partington, engineers, Market Street, Chapel-en-le-Frith. (Fee £5 5s., returnable.)

Haywards Heath, September 23.—Small oil-engine-driven centrifugal pumping set in duplicate, with all pipes and appurtenances, for the Mid-Sussex Joint Water Board. Mr. W. H. Ashmole, engineer and manager, Waterworks Offices, Boltro Road, Haywards Heath. (Fee £1 1s., returnable.)

Portsmouth, September 9.—Castings for beam-engine pumps, for the Town Council. The City Engineer, Guildhall, Portsmouth. (Fee £1 1s., returnable.)

Prestwich.—800 yds. of 4-in. dia. cast-iron gas mains, with valves and fittings, for the Committee of Visitors of the County Mental Hospital, Prestwich, Manchester. Mr. A. R. Dowling, clerk and steward.

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

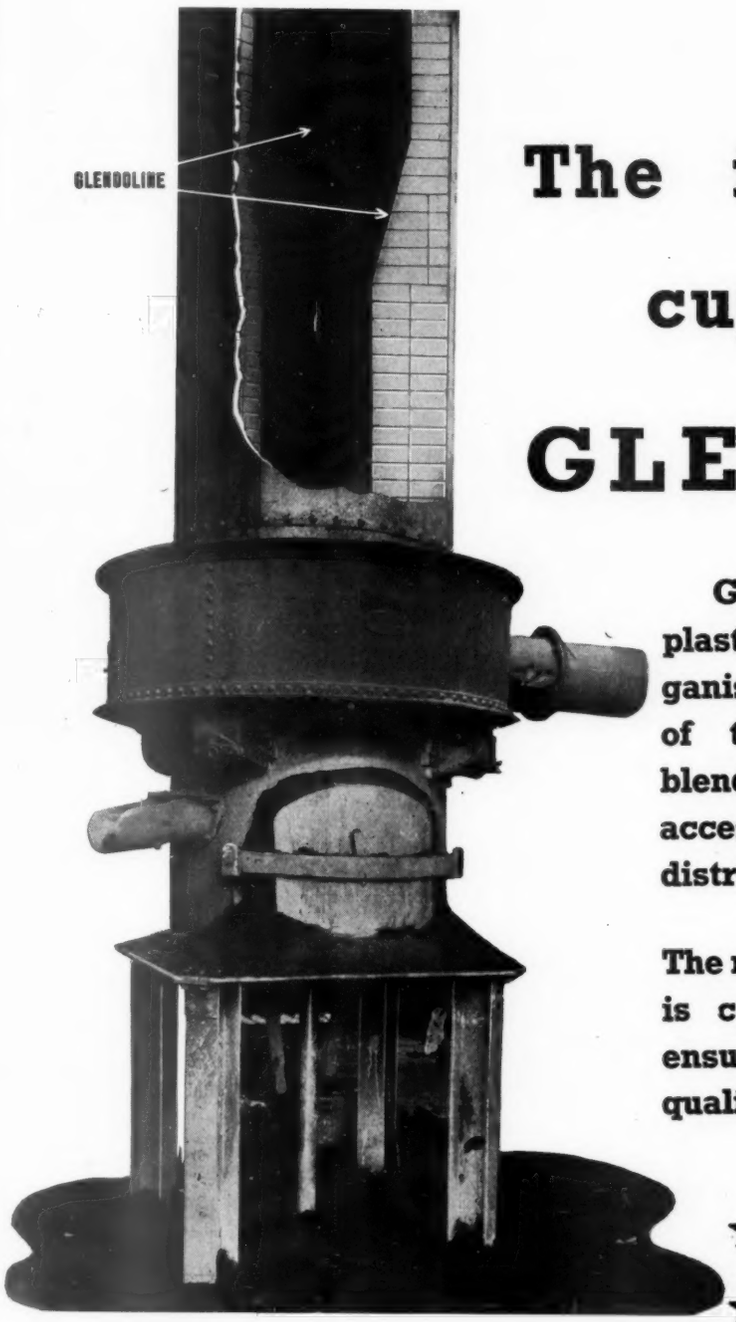
Crucible & Electric Steels (P.H.B.), Limited, Surrey Works, Broadfield Road, Sheffield.—Capital £500. Directors: P. H. and L. Boyle.

H. Rolfe & Company, Limited, Harpers Yard, St. Johns Road, Isleworth.—Capital, £300. Welders, founders, etc. Directors: H. S. Rolfe and E. C. Meads.

Personal

MR. CHARLES KOEHLER, Vice-President of the French Foundry Technical Association, has been nominated to the grade of officer of the Legion of Honour. Mr. Koehler is also the President of Arts et Métiers Old Students' Association; chairman of the St.Ouen Foundry Company; Vice-President of the Paris Foundry Employers' Federation; and general secretary of the National Foundry Employers' Federation.

* No. 705. H.M. Stationery Office, York House, Kingsway, London, W.C.2. (Price 3s. 6d. net.)



★ This photograph of a cupola, shows a portion of the lining and the positions where Glendoline is recommended for lining and patching.

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MIDDLESBROUGH OFFICE: Halifax Bldgs., Exchange Place. Telephone: Middlesbrough 3313. Telegrams: "Genefax, Middlesbrough."

BIRMINGHAM OFFICE: 5, Lower Temple Street. Telephone: Midland 6376. Telegrams: "Genefax, Birmingham."

Raw Material Markets

While the uncertainty of the price position for next year's deliveries of pig-iron persists there is unlikely to be any new business of importance. Consumers in most instances are in possession of adequate tonnages to carry them over the next month or two, and where further supplies are required users are only contracting for small tonnages.

Pig-Iron

MIDDLESBROUGH.—It is understood that a few export orders have been circulating in this market recently for September delivery. This is very welcome news, and it is hoped that there will be a further revival in this section, as the export market has been depressed for several months past. In the home market, also, there are signs that there will shortly be a return to more active conditions, and a number of consumers are reported to be very near to the end of their supplies. Nevertheless, until prices for deliveries after the end of the year are made known only small tonnages are likely to change hands. No. 3 Cleveland G.M.B. foundry iron is quoted at 109s. per ton delivered Middlesbrough or Falkirk, and 112s. delivered Glasgow. These figures are subject to 5s. per ton rebate.

While there is a little more interest being displayed in the hematite market, this section of the trade remains on the quiet side. Most users are fairly well stocked and specifications for deliveries under contracts are coming through rather slowly. Apart from low-phosphorus hematite, sales are very difficult to make. Prices of ordinary mixed numbers for delivery up to the end of the year are 132s. 6d. for North-East Coast consumers, 138s. in Sheffield, 140s. 6d. in Manchester, and 143s. 6d. in Birmingham, less 5s. rebate.

LANCASHIRE.—The pig-iron market in this area has recently shown signs of returning to more active conditions and the exchange meetings have been better attended. Contracts are expiring in many instances, but new orders are being confined to small tonnages. Jobbing and light-castings foundries continue to work short time; with regard to the latter, it is not now expected that there will be any improvement, as there is not much time to elapse before the customary seasonal quietness sets in. Quite satisfactory tonnages of pig-iron are being taken up by many of the speciality engineers. The hematite market is still very dull.

MIDLANDS.—A large proportion of the current output of pig-iron is being put into stock, as the demand is insufficient to account for the production, reduced as this is. Short time is still general at most of the light-castings foundries and the outlook for this section cannot be said to be at all bright. With the passing of fine weather, activity in the building trade is likely to be much reduced, and it is responsible for the consumption of a substantial quantity of castings. When ironfounders are in need of additional supplies of pig-iron they are generally limiting their purchases to small tonnages for early deliveries. Large stocks of hematite are on hand at most of the furnaces, and users are not showing much disposition to call for deliveries against contracts. The outlook is uncertain, but the heavy engineers and other consuming industries are expecting to become busier during the winter months. Quite an active demand continues to exist for low-phosphorus iron. Prices of this material are not controlled and current levels range from about £5 10s. to £6 15s. per ton.

SCOTLAND.—No interest in forward buying is being shown in the pig-iron market in this area. Supplies, of course, are plentiful, and there is no encouragement to users to place orders ahead. No. 1 foundry iron is quoted at 120s. 6d., with No. 3 at 2s. 6d. less, f.o.t. furnaces. Activity among the light-castings founders is still quiet and three to four days per week is generally being worked. While most of the local steelworks are fairly well employed, new business would be readily accepted. The works are well stocked with supplies of pig-iron. Hematite mixed numbers are quoted at 133s., Scottish basic 107s. 6d., and English and Indian basic 100s., all less 5s. per ton rebate, delivered local steelworks.

Coke

Prices of foundry coke are generally advanced during the autumn months, but this year it is unlikely that there will be any increases. Consumers have long been of the opinion that quotations were too high at their present levels, and had hoped that producers would make concessions in their price lists, but this has not been the case. Long-term contracts are not very popular and most consumers are restricting their orders to their requirements up to the end of the year. For delivery to Birmingham and Black Country stations, best Durham coke is quoted at a minimum of 50s. 6d. per ton, with Welsh coke at from the same figure upwards.

Steel

The situation in the steel market fails to show any marked signs of an early improvement, states the official report of the London Iron and Steel Exchange. Although the volume of inquiry has increased, only a comparatively small proportion has led to business and consumers in practically all branches appear to have adopted a policy of restricting their purchases to nearby requirements. Conditions in the semi-finished steel department are disappointing, and, although inroads have been made into the stocks, many consumers and some of the producers have accumulations on hand which stand in the way of the transaction of new business. Imports, however, are carefully controlled, and a revival in the demand for finished steel would quickly be reflected in an improvement in the semi-finished steel section. Irregular conditions rule in the market for finished steel. The heavy-steel makers have enough work in hand to keep them operating at a fair rate of capacity, but the amount of business coming forward is not sufficient to make good completed contracts. A few signs of increased activity are noticeable in the lighter sections of the trade, in which, however, there is a certain amount of unemployed plant. Export business is restricted, but there has been a slight increase in the inquiry from some overseas countries.

Scrap

In some districts business in iron and steel scrap is almost suspended. The outlook from a supplier's point of view is very unsatisfactory and quite different from the situation ruling last year, when scrap could not be obtained in adequate tonnages to meet the demand. Stocks at the consuming works are not being reduced at all quickly, and it will be a considerable time before users will be able to place further orders.

Metals

Business in Whittington Avenue has again been affected during the past week by the political tension arising out of the question of the position of the German minority in Czecho-Slovakia. Until this and other outstanding international disputes have been settled it is unlikely that trade in non-ferrous metals will be very brisk.

Copper.—Buying on industrial account in this country has continued to be rather quiet and consumers are withholding placing orders until the outlook becomes clearer. In view of the tense political situation it is somewhat surprising that buying for armament purposes has fallen off to some extent and foreign governments are also showing less interest. According to the "Metallgesellschaft," the world's smelter output of copper during the first half of the year totalled 944,775 metric tons, as compared with 1,141,833 tons in the corresponding period of last year.

Metal Exchange quotations were as follow:—

Cash.—Thursday, £40 11s. 3d. to £40 12s. 6d.; Friday, £40 6s. 3d. to £40 7s. 6d.; Monday, £40 12s. 6d. to £40 13s. 9d.; Tuesday, £41 3s. 9d. to £41 6s. 3d.; Wednesday, £41 to £41 1s. 3d.

Three Months.—Thursday, £40 15s. to £40 16s. 3d.; Friday, £40 11s. 3d. to £40 12s. 6d.; Monday, £40 17s. 6d. to £40 18s. 9d.; Tuesday, £41 8s. 9d. to £41 11s. 3d.; Wednesday, £41 5s. to £41 6s. 3d.

Tin.—Consumptive demand for tin both here and on the Continent remains at a low ebb. In the United States, also, the market has ruled quiet and the stoppage on Monday for the celebration of Labour Day further accentuated the dull tone. According to the statistics compiled by Mr. W. H. Gartsen (Henry Rogers, Sons & Company), the total visible supply of tin increased during the month of August to 30,671 tons, against 29,447 tons at the end of July. These figures include the carry-over in the Straits Settlements and at the Arnhem (Holland) smelter. It is reported that the increase had been anticipated in Amsterdam, and although it is still unknown what quantity of this increase is due to the establishment of the buffer stock, it is believed that without such buffer pool production stocks would have shown little change on the previous month's figures.

A report from Singapore states that it is understood that the Malayan Government has decided against requesting the International Tin Committee to grant a further increase in the standard tonnage. It is felt that the present is not the time to enforce a demand for revision.

Official quotations were as follow:—

Cash.—Thursday, £192 15s. to £193; Friday, £191 5s. to £191 15s.; Monday, £192 to £192 5s.; Tuesday, £192 10s. to £193; Wednesday, £190 15s. to £191 5s.

Three Months.—Thursday, £193 10s. to £194; Friday, £192 5s. to £192 10s.; Monday, £192 10s. to £193; Tuesday, £193 10s. to £193 15s.; Wednesday, £191 15s. to £192.

Spelter.—Interest in forward business in this metal is at a minimum. Supplies are plentiful and there is no encouragement to consumers to take up large tonnages in the circumstances. Recent sales have been only moderate, but a few users of the metal are negotiating while prices are still comparatively low.

Daily market prices:—

Ordinary.—Thursday, £13 3s. 9d.; Friday, £13; Monday, £13 1s. 3d.; Tuesday, £13 2s. 6d.; Wednesday, £13 2s. 6d.

Lead.—The tone of this market has been quiet during the past week. Small tonnages only are changing hands. Supplies continue to be available in large tonnages. At a meeting in London on Tuesday leading world producers of lead outside the United States decided to form an association. Co-operative measures to adjust output to demand are to be taken. World's smelter output of lead in June totalled 135,787 metric tons, according to the "Metallgesellschaft," who state that the total for the first half of the year was 805,723 tons, against 828,580 tons for the January-June period of last year.

Day-to-day quotations:—

Soft Foreign (Prompt).—Thursday, £14 1s. 3d.; Friday, £14; Monday, £14; Tuesday, £14 3s. 9d.; Wednesday, £14 13s. 9d.

Scrap.—This section has been quiet recently in sympathy with the trend of business in the virgin metals. Consumers are pursuing a cautious policy. Quotations are unchanged.

Approximate selling prices for old metal:—New aluminium cuttings, £67; rolled, £52; cast, £28; foil, £88 to £90. Copper, £36 to £40; braziery, £32. Brass (clean), £21 to £24. Zinc, £8 10s. Lead, £13. Gunmetal. £38.

Patent Specifications Accepted

The following list of Patent Specifications accepted has been taken from the "Official Journal (Patents)." Printed copies of the full Specifications are obtainable from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. each. The numbers given are those under which the Specifications will be printed and abridged, and all subsequent proceedings will be taken.

487,427. EQUIPMENT & ENGINEERING COMPANY, LIMITED, and SWIFT, H. B. Apparatus for detecting cracks or flaws in iron or steel parts.

487,428. SANDBERG, C. P., SANDBERG, O. F. A., and HUMFREY, J. C. W. Method and means for testing the abrasion-resisting properties of materials.

487,439. ROLFSEN, O. Production of pig-iron.

487,467. SPANNER, E. F. Welded compound girders.

487,553. INJECTA AKT.-GES. Manufacturing dense castings in pressure casting machines from alloys having a high melting point.

487,565. SIEMENS & HALSKE AKT.-GES. Devices for tilting high-frequency furnaces.

487,573. MANNESMANNROHREN-WERKE. Tube push bench.

487,670. STEVENS, A. H. (Continental Roll & Steel Foundry Company). Metallurgical furnaces.

487,692. KUSAKA, K., and ASHIDA, H. Manufacturing iron by direct reduction.

487,759. KRUPP GRUSONWERK AKT.-GES., F. Multiple rolling-mill.